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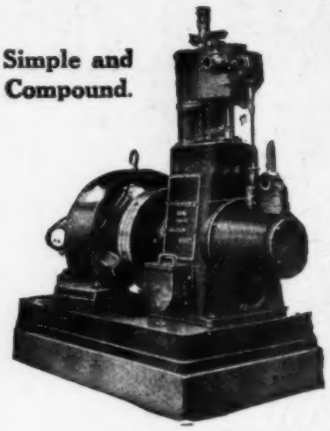

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ELECTRICAL REVIEW.

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EMPLOYMENT FOR THE DISABLED.

IN spite of all the efforts that have been made to train disabled fighting men and secure for them suitable employment, there still remains a large number—estimated at 100,000—who have not yet been absorbed into industry. About half of these are awaiting their discharge from hospital, and some 50,000 are now in search of a remunerative occupation.

We have always urged that these men, who have undergone such heavy sacrifices for their country, have an imperative claim not merely upon our sympathy, but upon our active and personal assistance in their search for means of livelihood, and therefore we cordially welcome the proclamation issued by the King on Monday last, calling upon every employer of labour to give employment to a fair proportion of the disabled men. We have no doubt that the attention thus directed to this very pressing subject will result in the provision of openings for the men referred to. Some 700,000 had already been taken into employment, and many employers had made themselves responsible for a far larger proportion than the one in 20 suggested; it may be that the remaining 100,000 include many of the more severely injured men, for whom it is very difficult to find suitable posts, but we confidently anticipate that in no long time the comparatively small residuum will have been provided for. While this is decidedly a case where "virtue is its own reward," the employer who loyally shoulders his share of the burden is to be granted the privilege of using a "Seal of Honour" in token of the fact, and this will undoubtedly carry a good deal of weight, both with the firms concerned and with their clients.

It is especially important and satisfactory to note that the Trade Unions, always suspicious of any attempt to introduce new hands into existing trades, and in some cases openly hostile towards the schemes that have been devised for the assistance of disabled men, have in this instance dropped their latent opposition, and express their sympathy with the movement. It is said that they feared that sound men would be thrust out of employment to make room for the disabled; that the latter would be utilised to depress wages, and that unskilled men would be put on work properly allotted to skilled men. Ample safeguards have, however, been provided to meet all objections, and the Ministry of Labour has discussed the matter during recent weeks with all the big Trade Unions, in order to ensure the success of the scheme. We understand that none of the Unions rejected the proposals, though several of the larger bodies have preferred to carry them into effect on lines laid down by their own executives. An appeal is made by the Ministry to the local officials of Trade Unions to carry out the arrangements to which their executives have given their approval, and to receive the scheme in a friendly spirit. We are glad indeed to see in the *Times* that Mr. J. O'Grady, M.P., secretary of the National Federation of General Workers, said that "We owe such a debt to these men that their employment must not be calculated in terms of money." That is the spirit that should rule us all in this matter. They have already done their great work, and their injuries remain as an investment, so to speak, upon which it is the duty of the whole nation to pay the dividends—partly in the form of State pensions, but partly, also, in the form of wages.

Small Electricity Supply Companies.

The present abnormal condition of things as regards high (and increasing) cost of material, labour, and all else, must sooner or later produce a critical state of affairs for small electricity supply companies. There are a large number of isolated company undertakings of less than 500 kw. in various parts of the country. The increase in running costs is an item of greater seriousness for them than for large undertakings. Their output is so limited that even a large percentage increase in the charge per unit does not compensate for the blocks of increased costs appearing at the end of the year in their revenue accounts. Further, the increased cost of plant and mains will sooner or later put a stop to their development. In a small undertaking the margin between profit and loss is in absolute figures very small indeed, and the present rises in prices must shortly make the situation almost impossible. In the earlier years of the war, the Board of Trade assisted some of these companies by granting a material increase in their statutory charges under the Electric Lighting Acts, but the introduction of the Statutory Undertakings (Temporary Increase of Charges) Act precluded further concession being made under the former Act, with the result that adequate relief is not now forthcoming. Whether the Electricity Commissioners will be in a position, when they have the powers of the new Electricity Bill in their hands, to give relief, is a question ; that certain small companies may benefit by the various district schemes that will be formulated is possible. But all this will take time, and meanwhile, the small companies have a hard struggle to make both ends meet.

The Measurement of Noise.

The engineer is responsible for a vast amount of the noise in the world, and equally with the general public, he suffers from the discomfort and mental fatigue which it produces. In fact he often suffers more acutely than the layman, for in addition to the physical assaults on his tympana of a noisy tramcar or a squeaking wheel, his engineering instincts are affronted by the mechanical inefficiency and destructiveness which the sounds denote. Useless in itself, like pain in the animal world, noise may serve the purpose of calling attention to conditions which, unchecked, would lead to disaster. The roar of a badly-constructed gear drive indicates a state of affairs which will prematurely terminate the life of the mechanism, and cavitation noises in a pump similarly warn the initiated that the impeller will come to an untimely end. Noises of this kind, therefore, cost money to produce, not only by the destruction of machinery, but also on account of the inefficiency of working which the noise denotes. The earlier types of motor-omnibus on the streets of London were said to have been withdrawn because "the noise they made could not be produced for 11d. per mile," and there is much wisdom in the statement.

Many kinds of noise, of course, do not indicate a serious mechanical loss or inefficiency. The din of a boiler shop, and the racket of a shipyard, are cases in point. The effect of such noises on cost is an indirect one. Quietness would not bring about any noticeable saving in power or material, but it would no doubt bring about an increase of production by increasing the comfort and endurance of the workers, facilitating the transmission of orders, and possibly by reducing accidents. However, even when noise cannot be shown to be actively injurious, it is to be condemned on account of its very uselessness. The production of noise is an infringement of the rights of everyone unwillingly subjected to it; and, in extreme cases, the law can be invoked in support of such rights.

Since artificial noise is so constant and exasperating a condition of our daily life, it is rather curious that no serious attempt has been made to define permissible noises on a scientific basis. Public motor vehicles which are too noisy are ordered off the streets by the police, who depend, we believe, entirely upon their own judgment and common sense in taking action. Tramcars, however, appear to enjoy immunity from such control, and may thunder along with an intolerable din. Certain kinds of noise are permitted, while others are forbidden, yet no one can define either the intensity or the pitch of a sound in relation to its legitimacy. Devices exist for the measurement of electricity, heat, or light to any required degree of accuracy. The intensity and distribution of light in our streets and rooms can be readily determined by means of the photometer, but nobody yet has devised an instrument for rendering a corresponding service as regards sound. The student of acoustics busies himself with musical notes and their properties, and the really practical problem of measuring every-day noises is entirely neglected.

The absence of any method of specifying sounds, either by comparison with some easily reproducible standard sound, or in some more fundamental manner, is a greater drawback than is often realised. For example, when an observer has learned for himself to distinguish the sound made by a submarine amid the chaos of water-noises heard in the hydrophone, there is no way in which he can record his knowledge or impart it to any other person. Similarly, the cry of the cuckoo or the song of the nightingale would be sounds irrecoverable as the note of the dodo with the extinction of the species which uttered them. The gramophone, it is true, will preserve some sounds for us with reasonable fidelity, but it affords no help to anyone wishing to impart the idea of a sound to another man by words or writing. Something much more fundamental is wanted, which will represent the air vibrations either visually, as a graph, or to the intelligence by means of numbers. In these days of refined physical measurements, it should not be impossible to devise something of the kind required, so that the investigator could study sounds of all kinds in a quantitative and, therefore, scientific manner, and the engineer could attack the problem of noise from the standpoint of a definite knowledge of the particular features which render certain sounds objectionable.

James Watt.

This week the memory of James Watt and his work has been appropriately honoured by a great meeting of engineers and scientists at Birmingham, where for so many years he lived and laboured, until, just one hundred years ago, he was called to rest. While Watt was not, as some seem to suppose, the inventor of the steam engine, he was the author of epoch-making improvements in its construction, and reduced the coal consumption from 20 lb. to 6 lb. per h.p.-hour. That was well over 100 years ago ; yet, with vastly more efficient methods and apparatus for research, the armies of investigators who have followed in his footsteps have only succeeded in repeating his achievement—there are few installations that can boast of using less than 1·8 lb. of coal per h.p.-hour to-day. But we know that even that amount is ten times as great as it would be if we could attain to an efficiency of conversion of 100 per cent. (on the pre-war basis of 14,000 b.th.u. per lb. of coal).

Truly there is still a great deal to be done, and we sadly need another Watt to show us the way to the acme of economy.

But let us not forget, in contemplation of Watt's most famed achievement, that he was a profound thinker and a prolific worker in many other fields besides steam engineering ; he was an able civil engineer, an instrument maker and inventor of great skill, and a philosopher. To him we owe the origin of the decimal system of weights and measures, while the list of his mechanical inventions covers an extraordinarily wide range.

Most appropriately the chief memorial that is contemplated is a Chair of Research at Birmingham University, of which the first task would be to carry on his great work of economising fuel, and we wish success to this worthy scheme while we pay homage to the memory of one of our greatest engineers.

THE PRODUCTION OF ELECTRO-MEDICAL APPARATUS IN GREAT BRITAIN.

By CUTHBERT ANDREWS.

(*Concluded from page* 325.)

So far we have considered only the production of appliances for generating and utilising X-rays, but we now pass to the wide range of apparatus which is included under the heading of "Electro-Medical." This comprises instruments for all forms of treatment of disease by electric currents, and embraces appliances capable of administering different classes or qualities of current as indicated by experience to be the most suitable for different

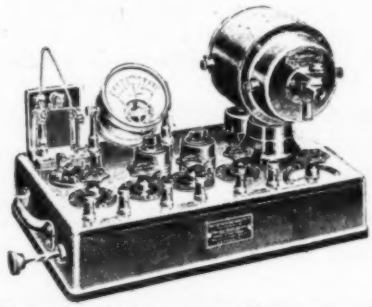


Fig. 8.—Universal Apparatus for Therapeutic Purposes.

pathological conditions; apparatus for the utilisation of the curative properties of light and heat, fat reducing apparatus, &c.

It has long been known that the oscillations of æther within the body, when absorbed, develop heat and increase the internal temperature of the body. The electric current also in passing through the human body experiences resistance resulting in a

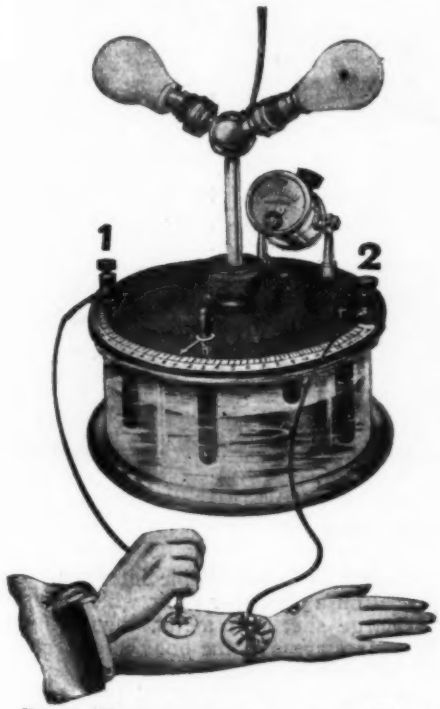


Fig. 9.—Therapeutic Apparatus with Water Resistance.

transformation of energy which develops the so-called Joule's heat. In all these cases, however, only a slight development of heat, and, therefore, only a slight rise of temperature, takes place.

A much greater development of heat is caused, however, when suppressed electric waves of high frequency are passed through the body. In diathermic treatment this process is now utilised in various therapeutic applications.

One of the most useful of these appliances is the machine known as the universal apparatus, a type of which is the plurostat (fig. 8). This consists essentially of a double wound motor which, while working from the ordinary mains, acts as a generator maintaining a voltage of 60 to 80 volts. Thus the risk of shocks to the patient is reduced to a minimum, while the pressure is sufficient for all purposes. Such a machine is employed for galvanisation (for ionic medication, electrolysis, electrical massage, treatment of neuritis, rheumatism, &c.), sinusoidal faradisation (for stimulation of muscles), cautery, and lighting of various types of electric lamps used in surgical explorations; while the motor may be used as an ordinary source of mechanical power, and employed as a drive for drills or burrs, vibrating attachments, or even for fans or centrifuges. It will be seen that an enormously wide field of work is thus covered, and in connection with the after treatment of the wounded much has been done by electrical means. Drugs and medicaments are introduced into the system by electrolysis, stiffened joints are benefited, muscular and nervous affections relieved.

An interesting variation of the machine described above is the appliance shown in fig. 9. This consists of a vessel containing water into which the main current is conducted by two electrodes placed on

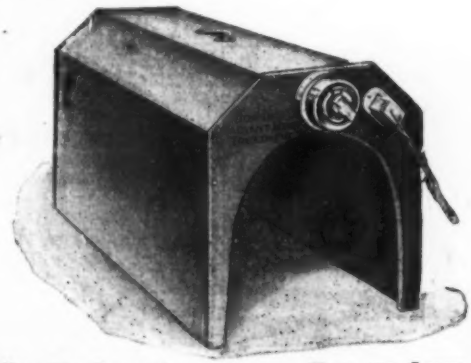


Fig. 10.—Small Applicator for Heat and Light Treatment.

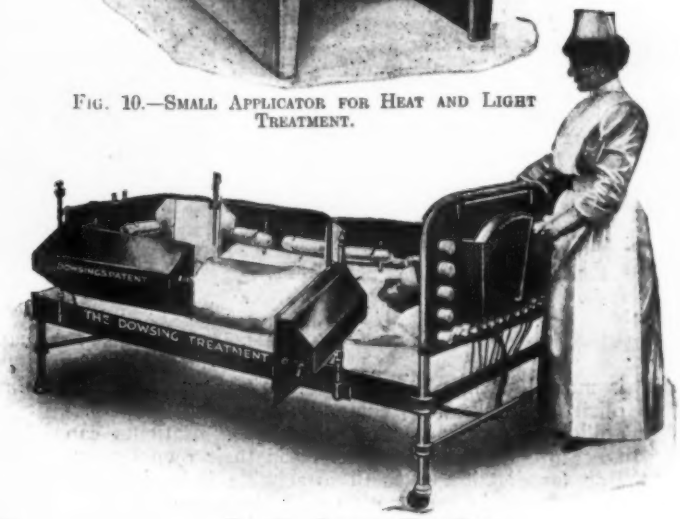


Fig. 11.—Radiant Heat Bed.

opposite sides of the vessel. At right angles to these two electrodes a second pair of electrodes is placed in the water; these are connected to the patient. As long as the two electrodes, which we will call "patient" electrodes, remain at right angles to the two electrodes, which we will call "supply" electrodes, no current will be obtained,

as the electrical potential in this equidistant position will be zero. The supply terminals (+and−) are mounted on a disk of vulcanite, arranged so that the disk is free to rotate over a graduated celluloid scale. If this disk is now rotated from its right angle or zero position, any desired current can be obtained from minimum to maximum by the most gradual increase. If it is desired to reverse the polarity of the current leading to the patient, the disk is brought back to its zero right angle position and then rotated in the opposite direction; by moving the lever backwards and forwards over the scale an undulating reversing current is obtained. The frequency of these undulations can be increased or decreased by varying the speed at which the lever is moved. This device has the great merit of simplicity with resulting economy in upkeep, and portability, the weight being only 7 lb. Patients can therefore be treated in bed or in their own homes. For faradisation a small attachable induction coil is employed in conjunction with the apparatus.

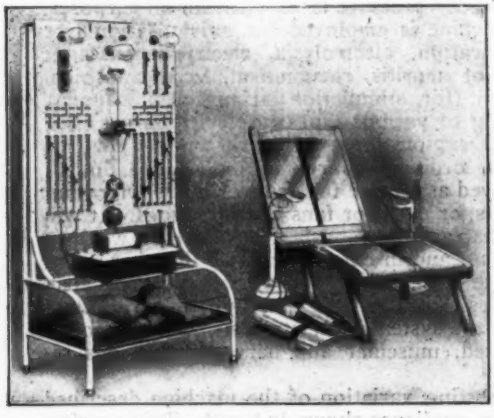


Fig. 12.—Bergonie Fat-reducing Apparatus.

Treatment carried on entirely by the action of light and heat (the so-called "radiant heat" system) has also a wide sphere of use. In this system it is claimed that the actinic rays are reduced to a minimum, while the heat rays are utilised for stimulation of the tissues, and to increase the oxygenation of the red corpuscles. This method of using a number of lamps obviously permits of the treatment being localised, and thus we have various shaped containers, ranging from a small case for the treatment of an arm or leg (fig. 10) to a complete bed in which the whole body may be subjected to the "radiant heat" effect (fig. 11). Benefits appear to have accrued in such varied cases as gouty and rheumatic conditions, stiff joints, contusions, and sprains, malnutrition, feeble circulation, chilblains, and neurasthenia.

One of the most ingenious and interesting uses to which electricity has been turned is as a means of reducing fat in the human subject. The inception of this idea is due to Prof. Bergonie, and the present complete apparatus has been beneficially modified by British medical men and British manufacturers in co-operation (fig. 12). Briefly, the action is as follows: A specially wound induction transformer is provided, designed to produce a maximum of muscular contraction with a minimum of sensation. With this is operated an interrupter so arranged as to produce interruptions without sparking, and at known and controllable intervals. The patient is placed on a couch or chair which consists essentially of large sheets of metal, thus bringing considerable surface areas of the body into electrical contact. These metallic surfaces are covered with wet towels or lint, and are connected to the transformer, *via*, of course, a switchboard, which latter is of a special character having a number of rheostats and commutators which allow of a minutely selected current being employed. The source of power is the ordinary house service, and the patient having been suitably arranged, the treatment is commenced. Naturally the exact procedure varies with the case under treatment; but, broadly speaking, it consists of the administration of a modified faradic current

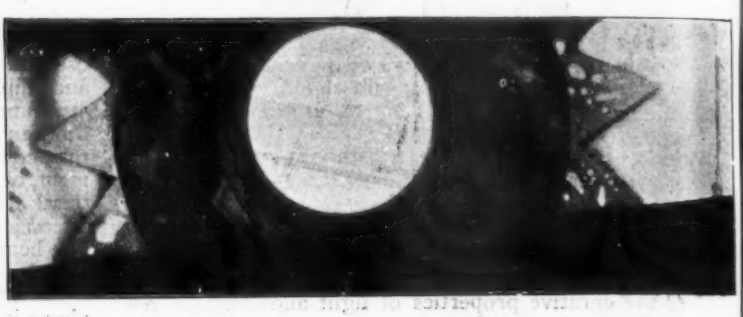


Fig. 14.—Pipe Soldered to Radiator.

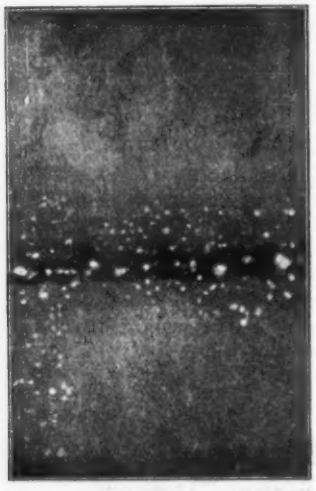


Fig. 13.—Butt Weld in Mild Steel.

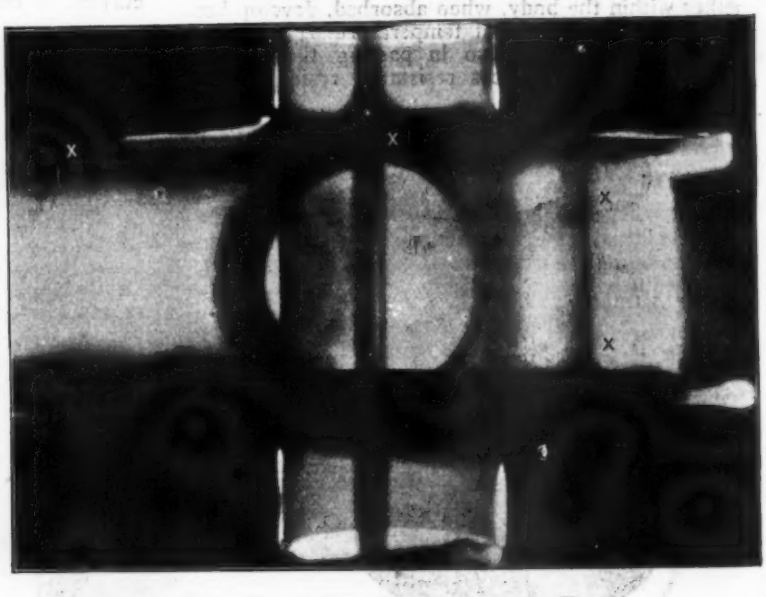


Fig. 15.—Welded Steel Joint in Aeroplane Frame.

Figs. 13, 14 and 15.—Radiographs of Welded Joints.

which causes a rythmic muscular contraction. It is found that the result is the speedy reduction of adipose tissue, and a healthy stimulation of all the bodily functions. A further elaboration is the synchronisation of the interruptions with the heart beats of the patient. This appears to be of marked utility where the action of the heart is abnormal, since the current assists in the return of the blood to the heart, and tends to regularise its action.

The recent advances in the construction of X-ray tubes, and the corresponding improvements in apparatus for the production of the necessary high-tension current, have made it possible to examine the internal structure of steel plates and castings, as well as of less dense materials such as aluminium and wood. The radiography of thicknesses up to 2 in. of ferrous metals has been successfully effected, and regular advances are being made in the knowledge and technique of the subject.

As to uses, flaws, and blowholes in castings and welds show clearly. In an X-ray photograph a flaw 1 mm. diam. in the plate 2 cm. or 3 cm. thick shows very distinctly, and much smaller defects can be detected. Porous places show up as well-defined light patches. The quality of electric and acetylene welds can be determined. Where union is incomplete the edges of the original plates can be distinctly seen, while in a good weld, the boundary between the plate and the added metal vanishes completely. The size and number of blowholes in the molten portion are very plainly shown; the small blisters in the plates themselves show up as very distinct light spots, thus indicating whether the plates have been damaged by the heat. Different qualities of metals are shown by different densities in their images, *i.e.*, a wrought rivet in a casting of the same metal shows plainly a darker image. Carbon, manganese, and tungsten steel all give images of different densities for equal thickness. Considerable use may be made of the rays in detecting lack of homogeneity in alloys, uneven distribution of a constituent showing plainly as a patchy structure in a radiograph.

In the examination of timber up to 18 in. thick X-rays are very useful. Internal knots, resin pockets, bad shakes, cracks, and grub holes are easily seen. Great use has been made of X-rays in the examination of inaccessible parts of wooden structures, such as hollow spars for aeroplanes, or the inner layers of plywood, where the quality of the material and workmanship cannot be ascertained by the usual methods. The purity or otherwise of insulating materials for electrical use can be rapidly ascertained, small metallic specks in fibre or mica, for instance, being instantly detected.

As to apparatus, necessarily the details depend largely on circumstances, but the equipment will always consist of the same principal parts; a current supply, control apparatus to regulate the output, transforming apparatus to raise the voltage to the required high pressure, X-ray tubes, photographic plates and screens, and lastly, a support and container for the tube, to hold it safely in proper relation to the object to be radiographed, and at the same time to shield the operator from the rays.

The high-tension current must be unidirectional, and two different types of apparatus may be used for producing it, that is, a transformer with a rectifier, or an induction coil, and interrupter. Either type will do good work, and opinion is greatly divided as to which is the better.

The induction coil outfit is lighter, less expensive, and uses less current, but the transformer machine is simpler to manipulate, eliminates several pieces of auxiliary apparatus, and makes it easier to reproduce conditions.

Examples of radiographs are given in figs. 13, 14, and 15. Of these, the first is a butt weld in mild steel. The joint is good, but the metal of the actual plates was damaged by overheating. The radiograph shows numerous blowholes occurring in the region where the metal was very hot but not molten. The metal was cut electrically along one side. Fig. 14 refers to the outlet pipe of a radiator soldered to the bottom of the radiator by a round flange and strengthening flange of star-shaped periphery. The view brings out the state of the soldering, the darkest part showing where the solder has taken in both joints, the medium parts where one joint is good, and the light parts where the solder has taken on neither joint. Finally, fig. 15 relates to a welded steel joint in an aeroplane frame, the joint being six-way for circular struts and wires, and flanged for the rectangular main longeron. The weak spots in the welds are shown where marked by letters X.

It is hoped that the foregoing may give some general idea of what is taking place in the realm of medical electrical work and radiology. Of necessity, the references have been of the briefest nature, as to elaborate the detail of the work and the apparatus employed would fill a number of volumes. One must realise, however, that we are only on the outskirts of this new science, and there is no doubt that the next few years will see great advances, both in appliances and methods, which will be, we trust, substantially to the relief of suffering and therefore to the general benefit of mankind.

The writer wishes to acknowledge the assistance received from the following firms, both in the matter of information and the loan of blocks: Messrs. Harry W. Cox & Co.; Messrs. A. E. Dean & Co.; the Cavendish Electrical Co.; the Medical Supply Association; and Messrs. Newton & Wright, Ltd.

THE DEMONSTRABLE CLAIMS OF SCIENCE.

A short time ago the Admiralty issued, with voluminous and tabular appendices, the new scale of Naval officers' pay, and we are glad to find that this not only includes considerable increases for practically all branches of the Service, but also definitely recognises the very important fact that the Scientific branches of the Service deserve higher remuneration than others.

Speaking generally, the engineering and medical branches benefit more than any others from this new scale. Perhaps it will be best to illustrate what has happened by taking a few isolated cases, because it is quite impossible to arrive at any definite percentage rates, although an effort has been made to do so. In the executive branch a Commander, on promotion under the new scale, is entitled to £2 a day, but the Engineer-Commander, or Commander-Engineer, is entitled to £2 5s. (we notice that although it is definitely stated that "The distinctions in pay between engineer officers of the old and new schemes are to be abolished," yet there is still a distinction of titles of Engineer-Commander and Commander-Engineer, Engineer-Captain, Captain-Engineer, &c., thus keeping up the very unhappy distinction between those engineer officers who entered under the old scheme through Keyham College, and those who have entered *via* Osborne and Dartmouth). We should like to see this distinction abolished at once, and all of them called by the same title; and we leave others to argue whether Engineer-Lieutenant is better than Lieutenant-Engineer, but as the Medical Branch is called Surgeon-Lieutenant, we see no reason why the word "Engineer" should not come first.

To return to the scale of pay, which, after all, is more important than titles, we find that a Captain in the Executive Branch, on promotion, receives £3, and that an Engineer-Captain obtains the same pay, and so it goes on up to the Engineer Rear-Admiral, who will receive £5 a day, the same as the Executive Rear-Admiral. It will, therefore, be noticed that it is in the lower grades of rank under Engineer-Captain that there is a difference in pay beneficial to the Technical Branch.

We now wish to turn to another question which arises out of this White Paper on Navy Pay, as a result of changed conditions. Prior to February 1st of this year, an Engineer-Commander received £1 4s. a day, and he is now

to receive £2 5s., which is a very substantial increase indeed. Under ordinary circumstances an Engineer-Commander is about 40 years of age on promotion, so that we see that he obtains just over £800 per annum and a substantial pension after a certain number of years' service. We recognise the fact that this man entered the Royal Navy under the competitive examination system, but it cannot be claimed that the ordinary rank and file are of any more exceptional ability than the average University graduate in engineering. We, therefore, think that it can be accepted in the profession that a man receiving a University training and working reasonably should expect to obtain at the age of 40 a salary of £1,000 per annum. When we consider other learned professions, we find that, if anything, they have better prospects than this—certainly as good—and, after all, there seems no reason at all why engineering should be worse off than, say, medicine and law. The training of an engineer nowadays involves three or four years at a University and the same period in a works, and although our medical friends may quarrel with this statement, we feel free to suggest that it is quite as difficult to become fully qualified as a professional engineer as to become a doctor. But we recognise the fact that doctors have organised themselves much better than have the engineers, and for that such bodies as the British Medical Council deserve full praise. In this new scheme issued by the Government we see that the Medical branch receives greater benefits even than the Engineering branch. Thus, an Engineer-Lieutenant receives £1 per day, while a Surgeon-Lieutenant, on entering, receives £1 4s. a day. We understand that the Surgeon-Lieutenant, on entry, may be a young man who has just graduated from the University, and if he went in for engineering he would probably enter as an Engineer Sub-Lieutenant at 13s. per day, although it must be stated that in the past the Admiralty has not encouraged the direct entry system for engineers.

A Surgeon-Commander and an Engineer-Commander receive the same, but the Surgeon-Captain receives 5s. a day more than an Engineer-Captain on promotion, and that also applies to the difference in pay between the Surgeon Rear-Admiral and the Engineer Rear-Admiral.

Now, we do not wish to quibble very much over this higher rate of pay, but we do think it is a reflection upon the engineering profession that there should be any difference at all. We are willing to admit that in practical politics there is not a great deal of difference between the £5 a day the Engineer Rear-Admiral receives and the five guineas a day which the Surgeon Rear-Admiral receives, but we are entirely at a loss to understand why any difference should exist. Both types of man reach the top of the ladder after many years of service, and under the new scheme for these Rear-Admiral Engineers, it seems that their training is really much more expensive than in the Medical Branch. Are we to believe that the British Medical Council or other national bodies have been more active than the Engineering Institutions? We have not seen the evidence which was given before the Committee which decided this question of Naval Pay. We notice that the Sub-Committee was composed of a Rear-Admiral, two Captains, a Commander, and a Paymaster-Lieutenant-Commander, who acted as secretary, and it would have seemed reasonable to suppose that a Senior Engineer Officer should have been on the Committee. However, we think that the moral of the whole business is that if these executive officers were convinced by the evidence that the engineering branch is entitled to higher pay than the executive branch, and if the Admiralty, which, at any rate in the days before Admiral "Jackie" Fisher, was none too sympathetic towards technical men, has approved of these new rates of pay, then it may be accepted as an axiom that they are well deserved. Further, we are delighted to find that this fact has been recognised by the lay Press, and we cannot refrain from congratulating a journal which is recognised throughout this country as strongly conservative and a firm believer in aristocracy and caste systems, upon the following words, for this is what the *Morning Post* says about the new rates of pay:—"Taken as a broad survey of a caste service where seniority and precedent count for so much, the amendments of pay and allowance hereby approved have been framed with a true sense of proportion and with an eye to modern ideas in regard to branches where tradition has been so slow until recent years to give place to the demonstrable claims of Science."

We have come across, in an accidental manner, additional evidence of the fact that scientific men are now able to claim better recognition for their services than was the case before the war. All of the readers of this journal remember Mr. Lloyd George's famous statement—"This is an engineers' war," and we have no reason to complain that in recent Honours Lists the Prime Minister has failed to recognise the obligations of the country, as a whole, to the engineering profession. But we are bound to say that there are still many people in this country who, either ignorantly or wilfully, cannot understand that a training for an engineer involves great expense and a long period of time, and therefore the individual concerned can fairly claim high remuneration. Not only is the training long, but throughout the whole of his career it is essential that the engineer should keep himself *au fait* with the latest developments in his work.

The additional evidence which we have mentioned can only be given in general terms, but we have all details, which have reached us in a confidential manner. And this is the story in outline. There were advertised posts for a prominent educational institution, and for these about one-half were for subjects such as history, economics, literature, &c., which generally come under the heading of "Arts," while others were for physics, chemistry, engineering, &c., commonly known as "Science." The idea of the authorities concerned (mostly non-scientific men) was that all of the lecturers should receive the same salaries. In actual practice the response to the advertisements was as follows:—For each of the "Arts" subjects, there were about 20 applicants, of whom at least half were men quite suitable for the short list, and there was very great difficulty indeed in deciding upon the best candidate, because they were all so good. In the "Science" section it was found that there were only two or three applicants, whose qualifications could not be compared relatively with those in the "Arts" section. We do not know what action has been taken, but we have very little doubt that increased salaries will have to be offered in order to induce suitable candidates to come forward.

When we consider the Universities in this country, we notice a tendency to recognise the new conditions of living which the Navy has now recognised, in connection with the Junior appointments. Thus, in 1900, a Demonstrator in Engineering was offered £100 to £150 per annum, and now the same post carries £200 to £250 per annum. We notice lectureships at £350 and £400 per annum, whereas 20 years ago, as was then pointed out in these columns by a "University Lecturer," there was practically no rate of pay between a Senior Demonstrator and Lecturer at about £200 a year and an Engineering Professor at from £750 to £1,000. Thus we see that an improvement has been effected in the lower grades, but we believe that it is actually the case that some of the Chairs of Engineering in this country to-day are worth less than they were 20 years ago. However, against that we can record the fact that two Engineering Professors have been appointed as Chief administrative officers of modern Universities—Dr. Ripper, who is Vice-Chancellor at Sheffield, and Sir Alfred Ewing, who is Vice-Chancellor of the University at Edinburgh. We should like to see a very definite effort made, not only by the British Science Guild, but by all of the combined influence of technical institutions, to press the claims of Science in administrative work. A scientific training and works experience is quite as good as, and is usually very much better than, any training in a pure classical education. We have no hesitation in saying that the great weakness of the British Civil Service is its unscientific outlook. The Foreign Office is the chief sinner in this respect, and we have yet to learn the true story of how Sir Arthur Steel Maitland was compelled to resign his office in connection with overseas trade. We suspect the classically educated Civil Servants of a contempt for trade and modern science.

We have no quarrel with classical education as a portion of training, but it is an extraordinary thing that if an engineer or scientist is unacquainted at all with English

literature—which is very seldom the case—he is considered an uneducated man. But yet there are hundreds of Civil Servants in most important positions affecting the trade and general development of the British Empire, who are utterly ignorant of the elements of the laws of nature, and the why and wherefore of such obvious things as motor-cars and electric lamps.

We place these facts before our readers with the sincere hope that they will agitate on every possible occasion, and use their influence with the technical institutions, so that not only will the Civil Servants of the future be better trained than they are to-day, but that scientific men as a whole will receive fuller recognition from the rest of the community of the value of their work. This applies to the people not only of this country, but of the world at large. For it is only scientific knowledge that can solve the problems before humanity.

ENGINE CRANKSHAFTS.

Some Causes of Failure.

By EDWARD INGHAM, A.M.I.Mech.E.

During recent years, engine makers have devoted more attention than formerly to the design and construction of their crankshafts, with the result that crankshaft failures are not nearly so frequent as they used to be. The fact, however, that disastrous engine breakdowns, the consequence of failure of the crankshaft, continue to take place, shows that the question is one which still calls for careful attention, and a brief consideration of some of the causes of failure will not be out of place.

The principal causes are (1) unsuitable material; (2) restricted dimensions; (3) want of alignment; (4) fatigue; and (5) overloading.

Unsuitable Material.—At one time, crankshafts were commonly made of cast-iron, and even now, there are some old steam engines of the beam type in use provided with such shafts. Cast-iron is obviously a most unsuitable material. It is brittle; has a low tensile strength, and is generally a most objectionable material for resisting the various stresses to which crankshafts are exposed.

Wrought-iron has been largely used in the past, and there are many shafts of this material in use. Since the metal possesses great strength and ductility, there can be no serious objection urged against it. At the present time, however, and, indeed, for many years past, it has been almost the invariable custom to make crankshafts of good mild steel, which is superior in strength to wrought iron, cheaper to make, and is very ductile.

There are, of course, different kinds of steel shafts in use, such as "Bessemer" forged, "Siemens-Martin" forged, and "Whitworth" compressed steel. Of these, the last-named is, perhaps, the most suitable, but its expense prohibits its more general adoption.

At present, every care is taken in the manufacture of steel crankshafts, but occasionally the material does not receive satisfactory heat treatment, whilst the chemical composition is not always as it should be, and within recent years a number of failures have been attributed to one or the other of these causes. Every effort should be made by the manufacturer to produce a forging having as fine a grain as possible, a crystalline structure being as far as possible avoided. When the material is crystalline, there is a tendency to produce planes of cleavage, so that the tendency to fail is greater than it otherwise would be. Impurities of the nature of clay or sulphide are objectionable, and unduly reduce the strength of the shaft. A factor of the utmost importance is the percentage of phosphorus and sulphur in the steel. An excess of either of these elements is most objectionable, and seriously affects the reliability of the shaft.

Restricted Dimensions and Unsatisfactory Design.—Some years ago, steam engine crankshafts were commonly made of too small a diameter, and breakdowns from this cause were frequent. Apparently, designers did not take into account all the various factors which influence the safety of a crankshaft, and they were somewhat reluctant "to put more metal" into their designs. Repeated failures, however, served to satisfy them that increased diameters were absolutely necessary.

When the gas engine was introduced, crankshaft failures again became common; probably because the makers did not realise that the calculations which fixed the diameter of a steam engine crankshaft could not be safely applied to the crankshaft of a gas engine. The conditions of working are far more severe in a gas than in a steam engine, and for a given power, the shaft of the former should be considerably larger than that for a steam engine.

The determination of the stresses in gas engine crankshafts is somewhat difficult and uncertain, and a maker must rely largely on his own experience. However, it is the exception rather than the rule nowadays to find a crankshaft of any type of engine made of too small a diameter.

Whilst, as pointed out, crankshafts generally are now made of ample dimensions, it is nevertheless a fact that the shafts frequently present unsatisfactory features in design. A number of failures have been largely the result of indifference to the important question of providing large fillets in the shaft. Sharp corners or sudden changes of section are always liable to start a fracture, particularly in parts exposed to fluctuating stresses, and for this reason all fillets should be made of as large a radius as practicable. In one instance we have in mind, failure of the crankshaft and complete breakdown of the engine were shown on investigation to be entirely due to a fine cut made by the turning tool in forming one of the fillets. Ill-fitting keys are another cause of failure, though such keys in general lead to fracture of the flywheel boss rather than of the shaft. In any case, it is important that all keys should be very carefully fitted. Keyways with sharp corners are obviously open to the objection that they are liable to start a fracture both in the wheel boss and in the shaft.

Want of Alignment.—This is a common cause of crankshaft failures. It will be apparent that if the shaft is not truly in line, severe stresses will be incurred, and if the defect be not remedied, a breakdown is particularly liable to occur.

Want of alignment may result from a number of causes, as, for example, careless erection, sinking of the foundations, and unequal wear of the bearings.

In some cases the crankshaft is supported in three or more bearings, and it is then a difficult matter to maintain true alignment. It is a somewhat common practice with gas engines to carry the crankshaft on three bearings, the outer one being entirely detached from the engine frame, and no special provision being made to ensure alignment. Such engines are always liable to be out of line, so that severe stresses are induced, and a breakdown in such cases can scarcely be regarded as a matter of surprise.

Recent experience of Diesel engines appears to show that most failures are due to want of alignment of the crankshafts. The four-cylinder engine especially has proved itself susceptible to failure from the cause in question. In all cases frequent testing for alignment is very necessary, particularly when the shaft is supported in more than two bearings.

Fatigue.—There are many instances on record of engine crankshafts having failed without apparent cause. The shafts have been of ample diameter, the conditions of working satisfactory, and no evidences of weakness or fracture discovered, and yet failure has occurred, often very shortly after a close examination of the shaft. Such failures are entirely the result of fatigue, or the weakening which iron and steel undergo in consequence of repeated applications and removals of stress. It seems somewhat strange that a shaft which is, according to calculations, unquestionably strong enough to resist, perhaps, four or five times the stresses imposed upon it, should fail without giving any warning whatever. But that such is the case cannot be questioned in view of the large numbers of failures which have occurred in this way. Fatigue is always a factor which should not be lost sight of, and where an engine crankshaft has been running for many

years, the question of renewing it, although it may show no signs whatever of weakness or distress, is one well worth consideration. The number of applications of stress required to produce failure depends, of course, upon the range of stress; the greater the range the less the number of applications required. If the range of stress were sufficiently small, an indefinite number of applications of stress would not produce failure, so that by making the crankshaft of sufficiently large dimensions, it would be possible to eliminate fatigue. To do this, however, would mean prohibitive cost in the manufacture of the engine; hence the possibility of failure by fatigue is always one to be borne in mind.

A striking instance of failure by fatigue occurred some years ago in Lancashire. Two large steam engines were made by the same firm to the same specifications, each to drive a cotton mill. The conditions of working were identical. After working for about 20 years, the crankshaft of one of the engines failed from fatigue, and within a very short time of this, the crankshaft of the other engine failed in just the same way.

One can understand the difficulty which insurance companies experience in trying to induce a steam-user to renew a crankshaft when there are no indications whatever of weakness or fracture. That this is sound advice in the case of an engine which has worked for many years cannot be in any way questioned.

Overloading.—There can be no question that many cases of crankshaft failure are the result of continual overloading of the engine. If an engine is made to drive a load greater than that for which it was originally designed, the working parts are exposed to stresses greater than those which the different members were designed to resist, so that fatigue becomes a far more important factor than it would otherwise be, and it cannot be wondered at, under these circumstances, if a breakdown takes place.

The Importance of Frequent Inspection.—In view of the various tendencies of a crankshaft to fail, it is very desirable that, in addition to testing the shaft for alignment from time to time, frequent examination should be made for evidences of fracture. Probably the majority of the fractures which lead to breakdowns originate in the necks, where the section is smallest; a large number occur in the crank webs and in the crank pin. In the case of Diesel engines, it would appear that the great majority of breakdowns are the result of fracture of the webs.

Fortunately, a fracture is generally slow to develop, and, with good material, may take long to become really serious.

Close examination, with the aid of a magnifying glass, is necessary, and any markings should receive careful attention. Care is, of course, required to distinguish actual fractures from what are really reed and dirt marks. In old wrought-iron shafts these dirt marks are not by any means uncommon, but, apart from being evidences of an inferior quality of metal, they need not, as a rule, be regarded as important defects.

They should, however, be noted from time to time. We remember one case where a number of marks were discovered, but believed to be merely the dirt marks referred to. Occasional examination showed that the marks were gradually extending, and, some years after their appearance was first noted, they led to complete failure of the shaft, having extended right through the journal.

Any marks running in a circular or an oblique direction should be regarded with suspicion, as these are of a more serious nature than fractures running in a longitudinal direction. When such marks are discovered, it is a good plan to wrap a piece of tracing paper round the shaft and transfer the marks to the paper. The latter may then be applied to the shaft from time to time with a view to detecting any extension of the defects.

If, during the examination of a crankshaft, any evidences of overheating are discovered, a particularly close search for fractures should be made. It is well known that where trouble from hot bearings is experienced, those in charge will sometimes throw cold water over the bearings. This is a very unwise procedure, as the forces set up by the sudden contraction are liable to severely stress the shaft. In a number of instances, serious fractures have undoubtedly been the result of this objectionable practice.

THE MUNICIPAL TRAMWAYS ASSOCIATION.

(INCORPORATED.)

The annual Conference was opened at Dundee on Wednesday last. According to the official programme, the visitors were to be received by the Lord Provost (Sir W. Don, K.B.E.) and members of the Tramways Committee, in the Albert Gallery, after which Mr. Goodyer was to deliver his presidential address. Mr. Peter Fisher (general manager, Dundee tramways) was to give a short history of the city, and a paper by Councillor Kelly (convener, Glasgow Corporation Tramways Committee) on "Where do we Stand?" was to be read and discussed. On the following day a paper was to be read by Mr. A. R. Fearnley (Sheffield) on "Motor Omnibus Services," and discussed, and in the afternoon the annual business meeting was to be held. To-day the programme includes no technical business; there will be an excursion on the river to Kinfauns, passing under the Tay Bridge, and luncheon will be provided by the Lord Provost, Magistrates, and Town Council. We give below an abstract of Mr. Goodyer's address.

Presidential Address.

By T. B. Goodyer, A.I.E.E. (Manager, Croydon Corporation Tramways). (*Abstract.*)

In achieving victory, tramway undertakings have played no small or unimportant part. Many of them have been engaged in the production of munitions in huge quantities, whilst they have also provided special and greatly increased transit facilities for those engaged in war work. They have not, however, been subsidised by Government funds.

During the past 12 months we, as an Association, have had to deal with matters affecting our industry of a most vital and important character. We have arrived at a settlement of some of the problems which caused us, at the time, grave anxiety. Referring to the application of the National Transport Workers' Federation for reduced working hours and variations in conditions of labour, every credit is due to those tramway representatives who had to carry out the negotiations with the various parties interested, and who arrived at an agreement which in some respects has, for the first time in our history of tramway working, fixed conditions of service applicable to the whole of the undertakings in the country. Whilst it is obvious that the revised conditions of the operating staffs will entail a considerable increase in working costs, it will be agreed that we have, as employers, the right to look in return for increased efficiency on the part of the workers concerned.

All tramway systems, whether large or small, are a convenience to the residents of the districts through which they run; the owners, be they ratepayers or shareholders, are entitled to their share of the benefits, and those using the cars should be willing to pay such fares as will give a reasonable return upon the capital invested. Charges for all public services—railways, postal, and telegraph—have been materially increased, and, in view of the better circumstances of the classes forming the bulk of our tramway passengers, any revisions of fares which it has been necessary to make are more than justified, while many others are already overdue.

In 1902 Mr. John Young, in his Presidential Address, said: "Municipal tramways differ as properties in so many respects that the same practice cannot apply to all. . . . There is, however, one common essential to the success of such commercial undertakings, and, that is, that they must be managed on pure business principles." Mr. Young's opinion deserves, *to-day*, the most serious consideration of everyone concerned in the control of our undertakings. The tramway situation, two or three years hence, is likely to cause us some concern, when there is less money to spend on fares, and when operating expenditure will not be much less than just now. The formation of the Joint Industrial Council for the Tramway Industry entailed an enormous amount of labour upon the Executive Council, and it was a matter of considerable satisfaction to me when we met in London in May last to have the constitution endorsed with a few minor amendments.

We have also witnessed during the year an important innovation in connection with the transport industry of this country. I refer to the Ministry of Transport Bill.

On April 8, 1919, Sir Eric Geddes said that the reason for the

exclusion of the tramways was that the Government did not wish to be accused of taking over highly prosperous and remunerative undertakings, which were essentially the property of the community. We were apprehensive, in the first instance, that municipal tramway undertakings would be seriously interfered with, but the Ministry has no intention of taking over the working of our tramways.

Although the Board of Trade has done good work in the past, we look forward, with some degree of hope, that our necessities in the future will be even better looked after under the new administration.

The recently issued report of the Select Committee on Transport (Metropolitan area) recommends the setting up of a "Supreme Traffic Board for Greater London, possessing executive powers to control, co-ordinate and initiate, and to safeguard and further public interests." It is greatly to be regretted that, in spite of the exhaustive reports which Royal Commissions and Select Committees have made in the past, such a Board has not been set up previously. No doubt the reason is due to "other" interests blocking the way. It is to be hoped, however, that the problem of London traffic will now be seriously grappled with. The Board will accomplish much, if it eliminates, to quote the Committee, "avoidance of senseless and costly competition." The view is generally entertained that the competition with the municipal tramway undertakings, except during the period of the war, has been "aggressive" in character.

The Select Committee condemned the inequitable rating of tramways, and their contribution towards the maintenance of the surface of the roads, as compared with the immunity of the omnibuses from both these charges.

The special report of the Local Legislation Committee of last session refers to the anomaly of the compulsion upon municipalities to contribute to the upkeep and the cost of reconstruction of roads and the immunity of private enterprise therefrom, especially so far as motor omnibuses are concerned. This question, and the allied subject of rating of tramways, have recently occupied the attention of the Tramways Committee of the London County Council. They are both subjects that are ripe for re-consideration. The conditions that prevailed in 1870 have long since passed away—and yet we are tied down to the conditions of 1870.

The Committee commented upon the total "lack of reliable information and useful data in the possession of any of the Government Departments," or of the transportation agencies, for the purpose of arriving at a correct conception of the "science of movement" in a great area like that of the Metropolis.

Housing and transport in the immediate future are two of the most important matters which will enter into social politics; tramways especially (and also railless traction and motor omnibuses) will play a most important part in the new social life and development which is about to be inaugurated in linking-up new housing areas with industrial towns.

The Select Committee on Motor Traffic some years ago reported that: "The duty of originating and accommodating traffic schemes and regulations is, in the opinion of your committee, a municipal duty. The control of the streets is essentially a municipal function, and the same minds should have before them the question of the adequacy of the street facilities for traffic and its regulation, and the safety and convenience of pedestrians."

Lord Islington, speaking in the House of Lords on July 31st last on the Ministry of Transport Bill stated:—"Rapid, regular, and cheap tramway facilities are an integral and indispensable part of a successful housing scheme."

The various points I have just referred to will, I feel sure, have the earnest consideration of our municipalities in any new housing schemes which they propose carrying out.

There can be no question that the 12 months terminating with this Conference will rank in the annals of the Association as the busiest, most strenuous, and most important year in its existence.

(To be continued.)

WATER POWER IN CANADA.

Some Recent Developments.

(Concluded from page 351.)

A description of the great Chippawa-Queenston power development, referred to in the opening paragraphs of the last article, appeared in the June 25th number of the *Contract Record*; this enormous engineering project is being carried out practically without the use of steam, everything being electrified. The estimated cost of the development is 27 million dollars; there will be six units of 50,000 H.P. each, and the probable date of completion is given as 1923. The Hydro-Electric Power Commission of Ontario will then be in such a position that it may abandon advantageously the plant of the Ontario Power Co., situated in the gorge below Horse-shoe Falls, which the Commission secured by purchase.

This big development was undertaken so that two (and more) H.P. may be developed out of the same water which up to the present time has developed only 1 H.P. Further, it is being put through at a time when many people entertain anticipations of a coal shortage, and at the moment when young Canada (industrial) is upon the very threshold of an era of wonderful development. The whole enterprise is being carried through as a unit, the same engineers and officers controlling the whole work, all plans being laid with a view to dovetailing in the various sections of the work—a condition that would be impossible if work on the different sections were being carried forward by different contractors. In a word, the work is one big organised unit, allowing of no duplications.

The route of the big canal which will carry the water to the turbines at Queenston is shown in fig. 13. This route is about 12.75 miles long, with the intake on the Niagara river at Hog Island, Chippawa, about two miles above Niagara Falls. The tailrace is on the Niagara river about one mile above Queenston. The intake will be in what is known as the Grass Island Pool of the Niagara river. The mean monthly elevation of this pool varies about 1 ft.

The normal mean elevation of Lake Erie is 573 ft.; of Grass Island Pool, 563 ft.; of the proposed power house site, 247 ft.; and of Lake Ontario, 245 ft. Probably no river has a more uniform regimen than the Niagara. The minimum flow is about half the maximum, and over a period of 50 years the maximum difference in mean monthly levels under normal conditions, either at Queenston or Chippawa, amounts to only about 6 ft.

The intake was located at Hog Island partly on account of that point being just above the critical section at which the water begins to speed up for its passage over the Falls. Another reason equally important was the use which could be made of the natural channel of the Welland river, which

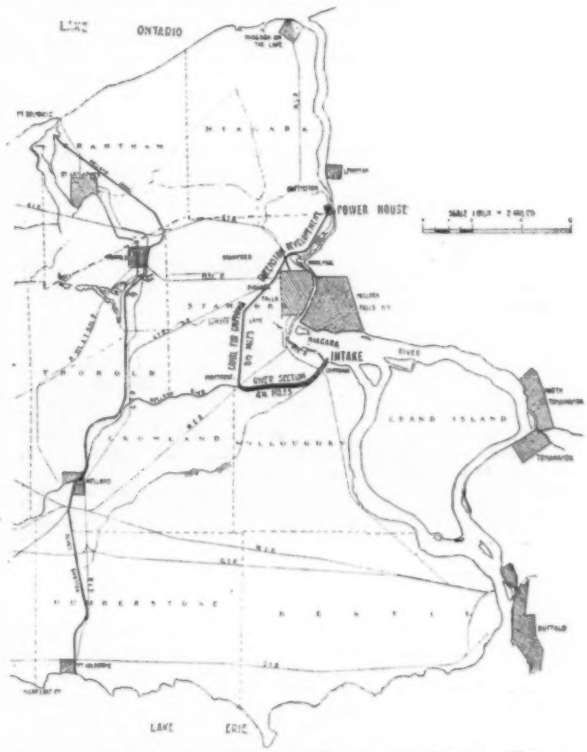


Fig. 13.—General Route of the Queenston, Canada, Hydro-electric Development.

comprises about 4.25 miles of the route of the canal, leaving only about 8.5 miles to be excavated, although the Welland river will have to be somewhat deepened. The flow of the Welland river, which is a sluggish stream with a very flat gradient, will be reversed for this 4.25 miles.

The gradients adopted for the canal average about 1 ft. per mile, or a total of about 8 ft. in the 8¼ miles of excavated canal. The net effective head will be 305 ft. under normal conditions. Of the 327 ft. normal difference in the level between the two lakes, only 22 ft. head will be lost—10 ft. between Lake Erie and Hog Island, 11 ft. between the intake and the tailrace, and 2 ft. between the point of discharge of the tail water and Lake Ontario. The power house will be located in the bottom of the gorge. The cliffs are nearly vertical at this point, and as the gatehouse will be on the cliff immediately above the power house, the penstocks will be nearly vertical, and only about 450 ft. long. With this scheme of development about 30 H.P. will be obtained from each second-foot of water used, compared with about 14 H.P. per second-foot obtained by existing plant at Niagara Falls. With 36,000, the whole treaty allotment of second-feet available, over 1,000,000 H.P. can be developed.

All the excavated section of the canal will be in solid rock. The velocity in the rock section will be about 6 ft. per sec., when the plant is under maximum load. At a point 2,400 ft. distant from the gate-house, the canal begins to widen into the forebay, the latter gradually increasing in width to 400 ft., which will be the approximate overall length

of the gatehouse. The initial development provides for 4 steel penstocks, each about 14 ft. in diameter, 450 ft. long; and one exciter penstock, about 5 ft. in diameter. Four main generating units will be installed, each of 50,000 H.P. capacity. Both the gate and power houses are so designed that they may be extended whenever conditions warrant. The surveys for the work commenced in 1914 and during 1917, the construction plant was assembled on the site.

The equipment for earth and rock excavation includes the three largest electrically-driven shovels ever built. They are of the revolving type built by the Bucyrus Co. The shovels rest on 2 tracks (4 rails) 30 ft. centre to centre, and are mounted on 16 wheels. Each of the shovels has a nominal 715 H.P. upon a half-hour intermittent rating, weighs 300 tons, and has a capacity of 3,000 to 5,000 cu. yd. per 10-hours' day when handling earth. There are also five other electrically-driven shovels and a Lidgerwood cable excavator at work. It is estimated that 9 million cu. yd. of earth and 4 million cu. yd. of rock must be excavated, besides 2 million cu. yd. from the river section.

The Commission has purchased 150 cars, 7 40-ton steam locomotives, and 12 50-ton electric locomotives. The latter were built by the National Steel Car Co., of Hamilton, Ontario, 6 of them being constructed with General Electric and 6 with Westinghouse equipment. Fig. 14 shows one of the electric locomotives with double trolley arrangement (2 poles on each side). The railroad lines are all electrified, the trolley wires being offset on one side of the track, and carried in clamps devised by the Commission's line construction department. The clamps and hangers which suspend them from the poles are all made up of standard material, and are so arranged that the temporary use of the material does not injure it. Framed timber trestles are set alongside the dump and other temporary tracks to carry the trolley wire; the

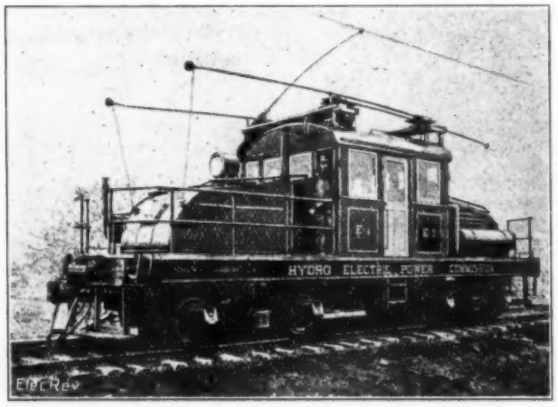


FIG. 14.—A 50-TON ELECTRIC LOCOMOTIVE.

trestles are mounted on wheels or skids, and can be removed rapidly by a locomotive crane when it is desired to shift the track.

Leading particulars are given in the *Electrical World* of one of three 32,500-K.V.A. generators which are being built for the Niagara Falls Power Co. An interesting feature of the purchaser's specification is that no restrictions are placed on the material used or on the weight of parts. Practically the only requirement is that highest efficiency be obtained, consistent with reliability. Sufficient reactance is demanded to protect against the strains which are likely to occur in operating large electrical systems due to insulation failure, distribution line troubles and mistakes in switching. Three such units have been ordered, one each from the General Electric, Westinghouse, and Allis-Chalmers companies. The latter will make both the waterwheel and the corresponding generator, while the waterwheels for the other two generators will be made by the I.P. Morris department of the William Cramp & Sons' Ship and Engine Building Co.

The mechanical stresses allowed in the generator described are in many cases no higher than is often allowed in cast iron, although best steel is being used. Owing to the relatively small losses which will occur, the insulation is not required to withstand abnormal tempefature, and the manufacturer's guarantee is a 100 deg. C. machine at 32,500 K.V.A. output. The insulation used is suitable for 125 deg. C., according to A.I.E.E. standards. The reactance of the generator is approximately 20 per cent.

The rotor spider consists of 6 wheels, each being a single steel casting. The hubs are rabbeted together and are of such length that a ventilating space is left between the rims. The weight of each pole piece complete without winding is 5,000 lb. The weight of copper in each field coil is 1,600 lb., the copper strips being wound on edge in the usual manner. The upper end of the vertical shaft of the generator is machined for a thrust collar which takes the entire weight of rotating parts, and for a guide bearing immediately below the thrust bearing. Only one other guide bearing will be provided, and that will be on the water-wheel.

The stator spider is in four parts divided vertically. The laminations may be assembled at the maker's works or the core may be built in the power house. The advantage of assembly *in situ* is that a continuous rim is obtained which may be clamped very firmly to prevent looseness and vibration of laminations. The stator winding is of the barrel type with two coil sides per slot; the slots are practically of the same dimensions as those of the largest steam turbine generators. The end turns of the stator windings are supported by bands of strong linen cord passing round supporting rings. This construction, in conjunction with spacing blocks laced to the sides of individual coils, is considered to be preferable to the use of rigid clamping rings. The more flexible construction reduces the risk of damaging the insulation.

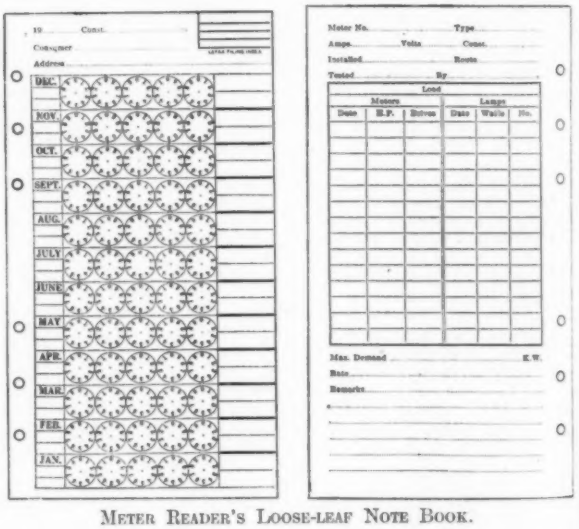
Air for ventilation is drawn in from the dynamo-room at both the top and bottom of the generator and expelled through ventilation holes in the stator spider into a casing which approximates to the surface of a cylinder half-way round the machine. This casing is connected to an outlet compartment underneath the operating gallery where a motor-driven fan is installed in order to assist air circulation when necessary. Fans are attached to the upper and lower rims of the rotor at the outer edge, and the fan action of the rotor will be highly efficient because of the provision made for passage of a large quantity of air through the rotor rim.

CORRESPONDENCE.

Letters received by us after 5 P.M. ON TUESDAY *cannot appear until the following week. Correspondents should forward their communications at the earliest possible moment. No letter can be published unless we have the writer's name and address in our possession.*

Meter Readers' Books.

With reference to Mr. Turnbull's remarks concerning the above which appear in the REVIEW for September 5th, may I suggest this form of loose-leaf which is printed for the purpose and used largely in America by meter readers. As will be seen the reading is marked by lines drawn on the dials, and then entered in plain figures in the space provided at the right. On the reverse side provision is made for a detailed record of the meter label, nature of the load, &c., as required. The pocket ring-book or binder used has a capacity for 70 sheets. It should be mentioned that the enterprising publishers supply an extensive line (some 2,000 so far) of



METER READER'S LOOSE-LEAF NOTE BOOK.

printed loose-leaf data sheets, covering all the engineering professions and industrial practices, together with an excellent collection of ruled blank sheets, co-ordinate papers of all kinds, and a monthly materials price sheet, with handy filing boxes, &c., which, in the opinion of the undersigned, comprises the most unique solution of an up-to-date pocket book for professional men extant, and is a worthy example which some British pocket-book manufacturers and publishers might well emulate to the mutual advantage and profit of both themselves and the industries concerned.

C. A. Smith.
A.M.I.E.E.

Birmingham.
September 15th, 1919.

[A similar pocket-book with loose data sheets for engineers was issued by Walker's as long ago as 1910. We reviewed it favourably at the time, and we have the book in regular use to-day. Did the American publisher get the idea from this British source?—EDS. ELEC. REV.]

Track Welding by the Metallic Arc.

Our attention has only just been called to an article with the above title in your issue of the 5th inst., which purports to give a fully detailed description with figures of costs, &c., of the welding of rails now being carried out on the track of the Sheffield Corporation Tramways. The method described was one which, as a result of many years' research and experience, was originally evolved by the Tudor Accumulator Co., Ltd., and later developed by the Rail Welding Co., which took over this branch of the Tudor Co.'s business. The welding of the track at Sheffield has been carried out continuously by these two firms for the last six years, and the work is still being done by the Rail Welding Co., both there and in numerous other towns in this country.

Under these circumstances, it has come as a great shock to us to find that the author of the article should have ventured to publish information which he obtained without our knowledge or consent, that he should have written the article without our authority, without showing us what he intended to publish, or without even having the courtesy to mention our name. Such a procedure is fortunately very rare in the technical Press, and we feel sure that in publishing the article, you, Mr. Editor, were unaware of the circumstances; it is akin to a person, who manages to obtain access to a works, publishing, without authority, details of a process he sees there.

We wish to say in conclusion that many of the details given in the article are inaccurate and incomplete.

The Rail Welding Co.
E. Jacob.

London, S.W.
September 16th, 1919.

[Certainly we were quite unaware that the publication of the article referred to might be detrimental to the interests of any person or firm.—Eds. Elec. Rev.]

Remuneration in British Commerce.

It speaks little for the tongue of rumour, or for the reputed power of gossip, that you should not yourself have supplied the answer to the question implicit in your leading article of the 5th inst.

Although the Society of Technical Engineers has not sought to publish its existence, I had thought that knowledge of its purpose might have reached your ears, for it is designed to avert the impending disaster of which you, rightly, warn your public.

Our countrymen who are answerable for the design and conduct of manufacturing and commercial enterprise dependent on applied science may not avail themselves of State protection, but they may organise defence, although you seem to doubt it.

Such of your readers as desire information as to what is being done in this direction should communicate with me.

Norman Wyld,
Gen. Sec., Society of Technical Engineers.

London, S.W., *September 9th*, 1919.

[As our correspondent is well aware, we are familiar with the existence and purpose of his society, which we described at some length in May last. The tenor of our leader was wholly in accord with the aims and policy of that society, and after studying the article at which he girds, we are at a loss to know why he so tartly criticises it. If this is the way in which the general secretary of the Society of Technical Engineers welcomes the efforts of his friends, Heaven help his enemies—and his society, for he will gain no sympathy by such tactics.—Eds. Elec. Rev.]

Two-Stage Theatre Lift.

Could you tell me whether a lift as described below has ever been constructed either in America or on the Continent, and what success it has had? The lift is wanted for a theatre, and would have to lift a portion of the stage 32 ft. by 20 ft., 20 ft. vertically, at which height a second floor is level with the stage, and a scene, which has been set (on this second floor) while the first act was in progress, is ready to proceed immediately.

If such a lift has been constructed for either electric or hydraulic power, can the maker's name be given?

F. L. Cater.

Hastings, *September 12th*, 1919.

Fatality.—The circumstances attending the death of James Fanghan, fitter at the Cleveland Steelworks, were investigated by the Middlesbrough Coroner on the 12th inst. Deceased was working on a 50-ton electric crane, and was found in a sitting position with one foot on a live trolley wire. On examination, the doctor found two burns on the left arm and hand, which suggested that the man had touched two live wires. The coroner's theory was that the man had stumbled and fallen against the wires. Deceased, added the coroner, seemed to have gone out of his way and thus exposed himself to danger. Artificial respiration was tried without result; no blame attached to anyone, and a verdict of "Accidental death" was returned.

NEW ELECTRICAL DEVICES, FITTINGS, AND PLANT.

Readers are invited to submit particulars of new or improved devices and apparatus, which will be published if considered of sufficient interest.

A High-Voltage Transformer.

Purdue University has been engaged in extra-high-voltage research investigations and tests for the past ten years. The present equipment, consisting of a 30-K.V.A., 220/250,000-volt step-up transformer, was constructed in 1909 from parts of the so-called million-volt transformer exhibited at the St. Louis Exposition. This apparatus, although not of modern design, has given very effective results, particularly in corona loss investigations on transmission lines. According to the *Electrical World*, in order that research work might be carried on, particularly in connection with the fixation of atmospheric nitrogen at extra high voltages, an extensive addition to the present equipment has been planned.

A contract has been placed with the Westinghouse E. & M. Co. for two single-phase 135-K.V.A., 300,000-volt, 60-cycle oil-insulated transformers, each with provision for one secondary terminal being earthed to the case. The other secondary terminal is provided with a condenser-type bushing, one coating of which provides charging current for a crest voltmeter. The two transformers may be connected in series on the secondary side in order to provide 600,000 volts between buses. In order that the power and current delivered by the secondary may be measured, provision has been made for the insertion of a portable ammeter and the current coil of a wattmeter between one of the secondary leads and earth by means of an ammeter jack on the switchboard. A film cut-out connected across the ammeter leads offers protection from high voltage in case this circuit should be accidentally opened. The potential coil of the wattmeter and a portable voltmeter may be connected to a tertiary coil so located in the transformer as to supply a voltage proportional to that of the secondary.

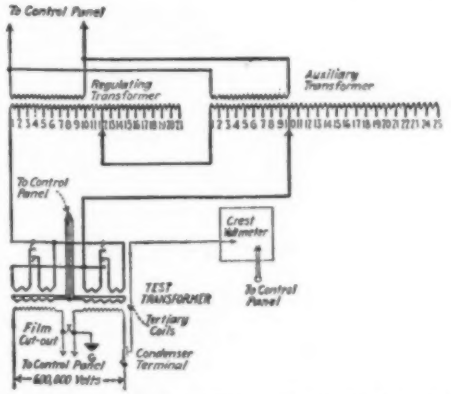


Fig. 1.—E.H.T. Transformer Control Diagram.

The step-by-step auxiliary transformer control, although somewhat complicated in its connections between transformer and controller, was adopted as best fitted to the demands upon the testing transformer. The objection often brought against this type of control to the effect that it involves too large fixed steps of voltage variation is very ingeniously overcome in the design of this controller. A regulating transformer is provided with 20 secondary taps supplying a corresponding number of voltages to the primary of the testing transformer. Each of these voltages may be further sub-divided into 24 steps by the floating secondary coil of an auxiliary transformer with 24 taps. In other words, the latter coil acts as a 24-division vernier which may be connected at will between the taps of the larger transformer, thereby supplying a total of 480 equal increments of voltage to the primary of the testing transformer. This arrangement will be readily understood from fig. 1. The proper sequence of connections is maintained by means of two control drums connected by means of a 24 to 1 gear ratio. After the 24 taps of the auxiliary transformer have been used to sub-divide the first coil on the regulating transformer, the second drum of the controller steps up the auxiliary transformer to the second coil of the regulating transformer, &c. Thus the entire range of the testing transformer may be covered by means of steps of one-fifth of 1 per cent.

In order to add further to the flexibility of control without excessive complication, provision is made by means of disconnecting switches for operating the two sections of the primary winding of the testing transformers either in series or parallel, for low and high voltage ranges respectively. One transformer only will be used for tests not exceeding 300,000 volts, while both units, with primary coils in parallel, will be connected in series for the higher potentials. Provision is being made for a third similar transformer to be installed in the future to provide for three-phase investigations with Y-connected units up to 300,000 volts per phase

or 520,000 volts between lines. The new transformers measure 15 ft. 4 in. (4.7 m.), from floor to top of high-tension terminal. Although the controller and auxiliary control transformers are located in the transformer room, remote control is provided from the main switchboard at the higher level, from which the operation of the equipment may be readily watched. Interlocking circuits connected with the gates leading to the control balcony provide protection for the operators, and cause danger signals to be displayed when the circuits are closed. The experimental high-voltage transmission line, with which corona losses have been studied for several years, will be connected to the terminals of the new transformers through wall bushings. Similar bushings provide high-voltage service to the lecture room and the present high-voltage testing laboratory.

The laboratory is being provided with an oil tank immediately under the high-voltage buses for insulation tests. In addition, a rain test for line insulators is being installed in the transformer room. Needle, sphere and horn-gap phenomena may be very conveniently and safely exhibited at the further end of the laboratory, where large plate-glass windows separate the audience from all high-voltage circuits.

A Shoe Collector Trolley Head.

A new type of trolley head, having a swivelling shoe in place of the usual wheel, has been placed on the market, after exhaustive tests and trials, by the Britannia Lamp and Accessories Co., Ltd., 48, Milton Street, London, E.C. 2, for which the following claims are made: Owing to the large area of contact sparking is eliminated with consequently less

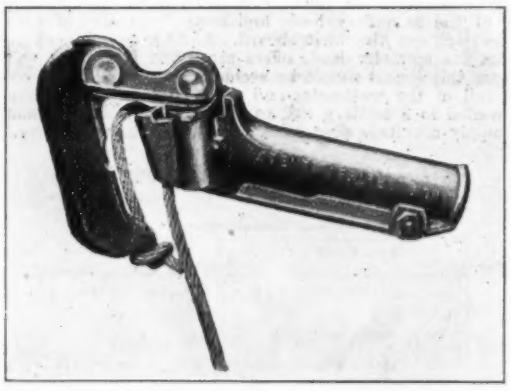
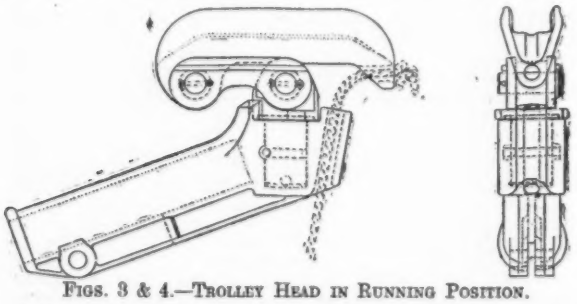


Fig. 2.—Trolley Head with Shoe Down.

wear on the wire and overhead fittings; frogs and crossings are taken at a much greater speed and with less knock than is possible with a wheel. In the event of the head leaving the trolley wires, it is impossible for the head to foul the span wires with the usual disastrous results; this is accounted for by the method of mounting (fig. 2), and the shape of the links enabling the collector to fall clear of the overhead



Figs. 3 & 4.—Trolley Head in Running Position.

fittings. By pulling on the trolley rope the shoe comes up into the running position and aligns itself with the pole; it is thus easy to replace on the trolley wire. If a bamboo pole is used for replacing the trolley head, a short length of rope should be used and fastened off on the boom about 6 in. from the frame, thus leaving a loop for the hook on the pole. The new head is lighter in weight than a standard swivelling head, and less tension can be used, due to the large area of contact. The cost of the shoe is less than half that of a standard wheel, and a shoe will outlast a wheel. Fig. 2 shows the head with the shoe out of action, while in figs. 3 and 4 the head is seen in the running position. As will be seen from the illustrations, the trolley head is of very simple design, the parts are few in number, of robust construction, and without complication. The mounting of the shoe is readily understood from the illustrations, and is such that the liability of leaving the trolley wire is much less than with a wheel. The shoe is constructed of a special quality cast iron, the two pins are of steel, and the body, swivelling part, and links of gun metal. After trials of some months' duration tramway engineers have expressed the following opinions: No apparent deteriorating effect on the trolley wire or overhead gear can be detected; there is less knock than with the ordinary wheel when passing under section insulators, ears, or through crossings. "As far as trials have gone we must say we are very pleased with its performance."

A New Water Turbine.

D. Banki, of Budapest, has devised a new water turbine to bridge the gap between the higher speed of the Pelton wheel and the lower specified speed of the Francis turbine. According to the *Technical Supplement to the Review of the Foreign Press*, the new turbine can be installed as simply as a waterwheel, and can be substituted for a waterwheel almost without structural alterations. It can be given the speed of the driven machine so as to eliminate gear transmission. Other advantages compared with waterwheel operations are low first cost, saving in space, higher efficiency, reduced operating and repair costs. Referring to fig. 5, the wheel consists of two disks carrying a series of cylindrical blades. The inlet is adjusted by hand, and the water imparts energy to the wheel both at entry and when it passes through the blades a second time at exit. The diameter of the wheel is independent of the quantity of water; the breadth of the wheel is chosen to suit the latter. Water is led

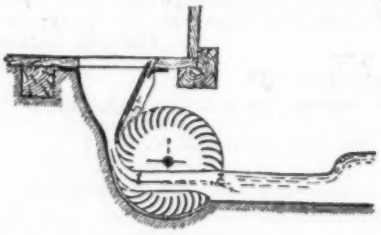


Fig. 5.—New Turbine.

to the wheel at an angle of 16 deg. The outer blade angle is 30 deg. and the inner blade angle 90 deg., so that in both places the water enters the wheel without shock. Tests with model wheels of the new type indicated efficiencies of 89 per cent. and 87 per cent. The reason for the high efficiency of the wheel is to be found in the simple, almost loss-free passage of water through the blades. The kinetic energy of the outflowing water can be utilised to maintain an artificially lowered level at the turbine. The wheel may run partially submerged without appreciable loss of efficiency. Where the downstream level is very variable the turbine is built in an airtight casing and the water is taken away through a suction pipe. The new turbine is recommended specially for driving high-speed dynamos.—*Zeits. Ges. Turbinenwesen*, Nos. 21-25, 1918; *Elektrot. Maschinenbau*, December 29th, 1918.

A New A.C. Potentiometer.

The construction, mode of operation, and use of a special form of A.C. potentiometer, particularly adapted to telephonic-frequency measurements, and which gives its readings in two rectangular components of the voltage measured, is described in the *Journal* of the Franklin Institute, for July last, by Messrs. A. E. Kennelly, Sc.D., and Edy Velander, A.M. The electrical connections of the new instrument are indicated in fig. 6. The resistance OA contains 50 ohms, in short coils, of Ia Ia wire, wound

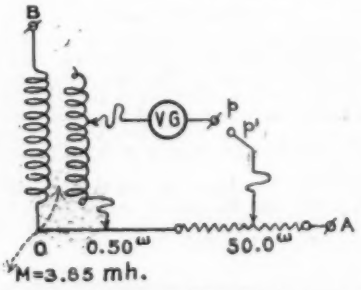


Fig. 6.—Connections of New Potentiometer.

both anti-inductively and anti-condensively, and also a short length of slide wire of 0.5 ohm. The mutual inductance coil has two equal copper windings, each having 8.8 ohms resistance at 20 deg. C., and 3.9 millihenries self-inductance. The mutual inductance between the two windings is approximately 3.85 millihenries. The potential difference to be measured is connected to the terminals P P'. A vibration galvanometer serves the balance indicator. The principle of the rectangular potentiometer described is not new, but the form of the instrument appears to be new. By the use of it, alternating potential differences can be measured, to rectangular co-ordinates, up to at least 2,000 volts, with only a small expenditure of power. The use of the instrument shows the

marked influence of distributed capacitance in A.C. apparatus, and the importance of reducing this disturbing effect when measurements are made. The importance of a proper earth connection in the working circuit is emphasised. The potentiometer escapes the necessity of measuring the strength of alternating current in either the potentiometer circuit, or the working circuit, provided that the relative method is used, and that the impressed frequency is mantained constant. Owing to the effects of distributed capacitance, the voltage distribution in a simple series resistance box, carrying alternating currents, fails to follow a vector straight-line law. The deviation tends to increase with the impressed frequency. The importance of reducing the mutual capacitance between the concentric primary and secondary windings of the toroidal induction coil, at high frequencies, is emphasised as the result of experimental tests.

BUSINESS NOTES.

Book Notices. — "Electric Mains and Distributing Systems." By J. R. Dick and F. Fernie. Second edition. Pp. x + 466; 162 figs. London: Benn Bros., Ltd. Price 18s. net.

"Automobile Batteries." By H. H. W. Cross. Pp. vii + 101; 24 figs. London: E. & F. N. Spon, Ltd. Price 4s. net.

"Electricity in the Service of Man." By R. M. Walmsley. Vol. II. "Technology of Electricity." Section II. Pp. viii + 688; 5 diagrams and 648 figs. London: Cassell & Co., Ltd. Price 10s. 6d. net.

Journal of the Institution of Electrical Engineers. Vol. LVII. No. 284. July, 1919. This issue contains the following paper:—"Large Batteries for Power Purposes," by E. C. McKinnon.

Openings for British Trade.—AUSTRALIA.—A consulting engineer residing in Sydney desires to get into touch with United Kingdom manufacturers of power plant and accessories, machine tools and machinery of all kinds, with a view to undertaking their representation in Australia. (Reference No. 590.)

CANADA.—A firm of manufacturers' agents at Montreal desire to represent United Kingdom manufacturers of industrial plant and electrical plant for sale on commission in Eastern Canada. (Reference No. 598.)

ITALY.—An electrical engineer, with good connections, who is at present in London, proposes to start buying on his own account, either as sole agent or buying agent for United Kingdom firms, and desires to obtain agencies for electrical goods, such as lampholders, lamps, switches, cables, &c. (Reference No. 616.)

Particulars from the Department of Overseas Trade, 73, Basinghall Street, E.C.

Import Restrictions.—At a meeting of the Leicester District Branch of the Federation of British Industries, on August 29th, Mr. Frank Moore, member of the Grand Council of the Federation and President of the Leicester Chamber of Commerce, said they must continue to press for a Minister of Commerce, who must be a man with business knowledge. If they were disappointed with Mr. Lloyd George, what could they think of Sir Auckland Geddes? He was reported to be responsible for the statement that high prices at home had this disadvantage—they made manufacturers less keen to export, because they could make sufficient profit by selling in the home market, and that was always less trouble. Such a statement would never have been made by a man with the most elementary knowledge of British methods of trade. If manufacturers had intended to confine their attentions to the home market, they would not have paid their Colonial representatives substantial retaining fees during the war. Japan and the United States had captured our Colonial markets, and now it was proposed to give them access to the British market in order to force British manufacturers to cater for the export trade! Manufacturers were only too anxious to regain their old position as exporters, but with the exchange against them they started with an initial handicap of 15 per cent. Yet the Government remedy was to allow manufactured goods to come in freely, thus increasing the handicap under which they were working. He thought it most desirable that steps should be taken to put before the nation the very serious results which would be the outcome of the Government's decision and present attitude. A resolution in accordance with Mr. Moore's suggestion was unanimously passed.

Conferences of Employers and Employed.—The striking success of the three days' Conference of Employers and Employed, recently held in Birmingham by the Industrial League, has encouraged it to extend its operations. Arrangements have been made to hold similar conferences in Glasgow, Newcastle, Manchester, Bristol, Portsmouth, and Sheffield, and negotiations are being conducted in other places. Subjects relating to labour and commerce in various forms will be considered. One very important subject to be dealt with was suggested by Mr. J. R. Clynes, M.P., in the discussion on his paper at Birmingham, on August 13th—namely, "The Relation of Improved Labour Conditions in this Country, and Imported Sweated Goods." This matter will be included in the agenda of one or more of the conferences.

British Westinghouse Co.'s New Title—METROPOLITAN-VICKERS ELECTRICAL CO., LTD.—The name of the British Westinghouse Electric and Manufacturing Co., Ltd., has been changed to that of "Metropolitan-Vickers Electrical Co., Ltd." The date of registration is September 8th, 1919.

Applications for British Trade Marks.—Appended is a summary of the recent applications for British trade marks in respect of productions connected with the electrical industry:—

Oldsol. No. 384,844. Class 13. Electric lamps; display stands, cases, and supports for electric light outfits; battery cases; clamps, switches, &c., for electric hand and vehicle lamps, &c. The Hawthorne Manufacturing Co., Bridgeport, Conn., U.S.A. August 22nd, 1918.

HH (design). No. 386,537. All goods in Class 8, but not including electric batteries, induction coils, and electric cables. Naamlooze Vennootschap Fabriek van Electrische Apparater voorheen F. Hazemeijer & Co., Hengelo, Holland. December 4th, 1918.

Ajax (lettering and design). No. 393,332. Class 11. Electric appliances for curative purposes. Ajax, Ltd., 25, Holborn Viaduct, London, E.C. July 15th, 1919.

Elect. No. 390,991. Class 13. Electric laundry irons. Gwylim A. Hughes, trading as the Electric Heating Co., 6A, George Street, Croydon. May 8th, 1919.

Telematic. No. 391,589. Class 8. Telephone apparatus. Leonard C. Bygrave, 4, Beaumont Avenue, Richmond, S.W. May 26th, 1919.

Beacon. No. 392,108. Class 18. Electric automatic fire alarms, being systems of fire alarms for use in buildings. Forbes Manson, Cromwell House, High Holborn, London, W.C. June 10th, 1919.

V.B. (torch design combined with lettering). No. 391,095. Class 13. Sparking plugs. Société des Anciens Etablissements Bardin, Renard & Conche, 30, Rue de la Briche, St. Denis, Seine, France. May 10th, 1919.

Magnetone, H.U. & Co., Oxford (lettering combined with design). No. 391,523. Class 13. An electric horn for motor vehicles and the like. Hill, Upton & Co., 22, George Street, Oxford. May 23rd, 1919.

Athens Exhibition.—A clear summary of the existing travel facilities overland from London to Mediterranean ports and thence by fast steamers to Piræus (port of Athens) has been produced by the London offices of the Italian State Railways. It shows that one can travel first-class throughout for £29 10s. (including sleeping car) and £16 10s. second-class.

British Empire Exhibition.—The Administrative Committee in charge of the British Empire Exhibition, 1921, has now received official recognition from the Government through the Board of Trade. Mr. Lloyd George is president of the Council; Mr. A. Bonar Law, vice-president; and Mr. Walter Long, president of the Administrative Committee.

Copper Wire Contracts in Australia.—According to *Tenders*, the Queensland Government recently accepted the tender of a British firm for copper wire for the electric power scheme in connection with the Inkerman irrigation works. In the course of a discussion on another matter, the chairman of the Metal Manufacturers, Ltd. (Mr. J. L. Wharton), stated that this company had been formed in Australia for Australian trade, and it wanted all the Government business in copper wire, copper tubes, &c. The company was in competition with active trade rivals—the Japanese and the Americans. Its tender was 18 per cent. above those rivals, so it lost the business. It was difficult to appreciate, added Mr. Wharton, how a Labour Government could refuse to pay 18 per cent. over and above the cost of the imported article, when every ton of wire manufactured in Australia from first to last meant the direct employment of at least 125 men. A Labour Government should not cut a company out of a contract simply because the price was 18 per cent. higher than someone else's tender, because this 18 per cent. was due to the higher wages paid, and the better conditions given to the workers. The mere fact that the order went to the agent of a British manufacturer did not affect the position. Australia wanted industries, and she could only get them if the people were prepared to support them. If the wire were not landed before the promised tariff came into operation, it would probably cost the Queensland Government more than 18 per cent. referred to—which would provide convincing proof that it was bad business not to give the company the order. Commenting upon the statements made, Mr. Gillies, Assistant Minister for Justice, Queensland, said he found that only two tenders were received in time to be considered. These were Elder, Smith & Co. (a British firm with a branch in Brisbane), and British Insulated and Helsby Cables, Ltd., as agents for the Metal Manufacturers, Ltd. The former was accepted, being the lowest tender by £210, and the wire to be of British manufacture. The amount of the accepted tender was £1,138. In January last, however, the tender of the agent for Metal Manufacturers, Ltd., amounting to £6,645 for wire for Inkerman was accepted, and given a substantial preference over tenders for American wire, also the wire was accepted in coils of 2,000 ft. in lieu of the lengths specified in the conditions of contract, this necessitated making more than double the number of 4 joints.

Profiteering Act.—The first order under the Profiteering Act has been issued by the Board of Trade, dated September 11th: it comes into force at once. Schedule 1 (E.) Building Materials, includes:—Tiles; light castings; zinc, copper, tin, and alloys; cast, wrought iron, and steel pipes; valves and fittings; electric cable fittings, plant, and meters; rolled joists; channels and angles, tees; bars and plates; plant tools and tackle required for the construction of buildings and public works. (The articles specifically mentioned in this Schedule are given as examples of the class of articles to which this Order applies, and any other article within the class is within the Order.)

A Swedish Amalgamation.—It is announced that the Elektriska Industrie, A.B., of Stockholm, has absorbed the Svensk Elektrisk Material, A.B., makers of electric heating apparatus. The former company produces telephone and telegraph apparatus and installation material, and is just making an increase in the share capital.

American Acquisition of German Firm.—It is reported from Munich as being probable that the firm of C. Conrady, of Nurenberg, will pass into the hands of an American financial group. In peace times the firm employed several thousands of workers at the Grunthal and Kolbermoor works, and had a large export trade, and a branch in England.

An Italian State Monopoly Tax on Lamps.—It was recently announced that the Italian Government had decided to introduce a monopoly tax on electric incandescent lamps made in Italy or imported from other countries, and that the State would acquire the whole of the native production of lamps and undertake the sale to the trade or consumers. The report has proved to be correct in so far as concerns the monopoly tax, judging from extracts from the official journal published in the Italian newspapers, but it is uncertain for the moment whether the State is, or is not, to engage in the merchant business, as was previously intimated. The decree provides for the imposition of a tax on native-made and imported lamps at the rate of 25 per cent. of their value, and in the case of the home-manufactured article the tax has to be paid to the Treasury before the end of the third week in every month. The annual sums payable by makers will be fixed by the general manager of the commercial monopoly on the basis of the presumed maximum annual output, which will be determined by the Technical Financial Office, assisted by an inspector of the monopoly, and makers are to lodge a deposit with the Treasury equivalent to two months of the presumed amount of the tax. In the case of lamps of foreign origin, the tax will have to be paid or collected on clearance through the Customs House, and for this purpose every delivery must be accompanied by an appropriate declaration of the value on the part of the forwarder and by a copy of the sales invoice.

The decree places upon existing native makers of lamps the obligation to give due notice of the fact to the general management of the commercial monopoly, who will then issue a licence to manufacture before the end of the present month. Those who wish to establish new lamp factories have to make application to the general management, when a licence will be granted. All factories having for their object the manufacture of incandescent electric lamps will be subject to the permanent supervision of officials and representatives of the financial administration. The decree further provides for the levying of financial penalties on the clandestine manufacture or importation of lamps and on incorrect declarations concerning the value of lamps imported. It thus happens that in placing a tax on lamps Italy has followed the example set by Germany many years ago, although the latter also included arc lamps and carbons, incandescent gas burners, &c., in her legislative action.

French Companies.—The Compagnie Générale de Distribution d'Energie Electrique has reduced its capital from 16,000,000 fr. to 12,000,000 fr., and raised it to 14,400,000 fr. on amalgamation with the Union Francaise d'Electricité, while changing its title to the Union d'Electricité.

L'Etincelle (the spark) is the style of a company just formed, with a capital of 500,000 fr., for the purchase and sale of electric and optical apparatus and instruments, &c. Its headquarters are at Paris.

Guidé et Cie has been established at Paris, with a capital of 100,000 fr., for the utilisation of every means of transmission of energy, electric and other, for lighting, heating, and motive power; also the construction, sale, and installation of electric, mechanical, and hydraulic machinery.

Danish Companies.—A new concession has been granted to the Kobenhavn Telefonselskab, lengthening its existence by 20 years. As a consequence, the Board has resolved to increase its capital from 18,000,000 to 50,000,000 kroner, in two instalments, the first issue of 18,000,000 kroner to be made at once.

The Maribo Elektricitetsværk has been taken over by a newly-formed company, styled the Maribo Oplands Elektricitetsselskab, with the object of embracing the supply of electricity to consumers in the Opland districts.

The Danske Kabelfabrik has decided to increase its capital from 2,000,000 to 3,000,000 kroner.

The Kobenhavn Telefonaktieselskab has decided to raise its capital from 18,000,000 to 36,000,000 kroner, the State consenting to take up half of the new shares.

German Steel Trust Dissolved.—The German Steel Trust has been dissolved, as from August 1st last, the firms composing the trust being at liberty to sell freely and to deliver directly to their customers after September 30th.—*L'Electricité.*

A Visit to Reyrolle's.—A visit was paid on September 6th to the works of Messrs. A. Reyrolle & Co., Ltd., Hebburn-on-Tyne, by over 300 members of the Foremen's Mutual Benefit Society. Several different types of switchgear were shown, the most outstanding feature of the exhibits being the super-power station switchgear, which was seen in operation. A souvenir booklet was presented to each of the visitors. After inspection of the works, tea was served, and a selection of music was given by the band. Mr. Burns, on behalf of the Society, expressed their thanks to the firm for the excellent entertainment, and said that they were also much impressed by the arrangements made for the welfare and safety of the employés.

Lead Market Report.—Messrs. James Forster & Co. say that there is little change to report in values for last week. The demand was steady throughout the week, and there was a great improvement in deliveries from some of the Government stores.

Messrs. G. Cawson & Co. note that Government stocks have again been drawn upon very heavily during the past month, to the extent of 23,953 tons. The supply of fresh lead remains as limited as ever.

Closing prices are:—Prompt and September, £25 5s. to £25 10s.; October, £25 7s. 6d. to £25 10s.; November, £25 12s. 6d.; December, £25 15s. to £25 17s. 6d.

"The Stuff to Give Them!"—*The Times* states that City merchants are showing little sympathy with persons of German or Austrian nationality, and the following notice is being posted on the doors of offices:—"Warning.—No German or Austrian admitted."

Excess Profits Duty.—The Association of Electric Power Companies, Incorporated, having made application to the Commissioners of Inland Revenue for an increase of the statutory percentage as respects the supply of electricity, the Board of Referees has ordered that the statutory percentage shall be increased:—

1. In the case of any trade or business carried on or owned by a company or other body corporate to 7½ per cent.

2. In the case of any other trade or business:—

(*a*) For accounting periods ending prior to January 1st, 1917, to 7½ per cent. plus 1 per cent.

(*b*) For accounting periods ending after December 31st, 1916, to 7½ per cent. plus 2 per cent., with the addition for accounting periods ending after December 31st, 1916, of 3 per cent. in certain cases.—*London Gazette.*

Sterling Merit.—The Football Section of the Sterling Athletic and Social Club (Sterling Telephone and Electrical Co., Ltd.), has got off the mark in good style, having beaten Hemingford (North-West Middlesex League and Cup Winners, 1916-17) by 9 to 0, Leyton A by 11 to 0, St. Erkenwald by 3 to 2, and drawn with Temple Mills (G.E.R.) 3 to 3. The club is competing in the London and Barking Leagues, London and Essex, Barking Charity, Ilford Hospital, London Business Houses, Cup Competitions.

Catalogues and Lists.—The B.E. Co. (of London and Birmingham), Ltd., 410, Mansion House Chambers, Queen Victoria Street, E.C.—Leaflets relating to insulated lampholders and "Rawlplugs" and tools.

Messrs. Landis & Gyr, Ltd., Windmill Road, Hampton Hill, Middlesex.—Leaflet showing D.C. watt-hour meters, type A B.

Messrs. Bagshawe & Co., Ltd., Dunstable—Leaflet relating to chains, sprocket wheels, and elevator buckets.

Powers Electrical Co. (N/c), of 21, Northumberland Court, Newcastle-on-Tyne, ask for price lists of lighting and power supplies.

Messrs. William Patterson, Ltd., City Wire Works, Walker Gate, Newcastle-on-Tyne.—Leaflet showing "Matchless" copper and brass wire gauze dynamo brushes, with prices.

The Isis Electrical Co., 57, Albert Road, Aston, Birmingham.—Card relating to polished brass switch plates, &c.

Messrs. Simplex Conduits, Ltd., Garrison Lane, Birmingham.—Leaflet of "Plexsim" electrically-heated domestic appliances, all taking under 600 watts, and suitable for working from a lamp-holder.

The New System Private Telephone Co., Ltd., 143, Great Portland Street, London, W.—Illustrated catalogue of telephone apparatus, automatic intercommunication telephones, &c., with a convincing essay on the importance of saving the "golden minutes" in home and office, and a long list of trades using the "new system" apparatus.

The Silent Electric Clock Co., Ltd., 192, Goswell Road, E.C. 1.—Handsome brochure describing electric clock systems, and explaining the advantages of the "Silectock" mechanism for the receiving clocks, which dispenses with ratchets and other oscillating parts, and employs a freely rotating armature, which is magnetically actuated and locked, and perfectly silent. Standard master clocks and various designs of dials, as well as turrent clocks, &c, are illustrated and described. A special line of master and receiving clocks is made for use on board ship.

Liquidations.—Fuller Accumulator Co., Ltd., Fuller's Wire and Cable Co., Ltd., Fuller's Carbon and Electrical Co., Ltd., and J. C. Fuller & Son, Ltd.—These companies are winding up voluntarily, the agreement with Fuller's United Electrical Works, Ltd., having been completed. Liquidator, Mr. H. M. Morris, Kennan's House, Crown Court, Cheapside, E.C. Meeting of creditors, September 24th.

Meirowsky & Co., electrical insulation manufacturers, Carriage Street, Old Trafford, Manchester.—Application by controller, Mr. G. H. Warmington, 33, St. Swithin's Lane, London, E.C., for release.

Surplus Stores.—The eighth number of *Surplus*, issued on Monday, gives particulars of an immense variety of Government property for sale.

Bankruptcy Proceedings.—W. J. McCombe, tramway manager, Hull.—First and final dividend of 4s. 4½d. in the £, payable September 22nd, at Union & Smith's Bank Chambers, Hull.

F. J. Hornett (Earle), electrician, Truro.—First and final dividend of 2s. 6½d. in the £, payable September 20th, at the Official Receiver's Office, 12, Princes Street, Truro.

Trade Announcements.—Messrs. Speedy & Eynon have changed their address to 22, Essex Street, Strand, W.C. 2. No change will be made in their telephone number.

The Pyrene Co., Ltd., is removing to more extensive premises; its address is now 9, Grosvenor Gardens, London, S.W. 1. Telephone numbers: Victoria 8592-3-4-5 (four lines).

Mr. E. R. Dunn, electrical engineer, of Queen Street, Ramsgate, has taken into partnership Mr. Geo. M. Willis, for 15 years a member of the staff.

Messrs. Giffin & Hosier, electrical engineers, have opened new premises at 30, Chequer Street, St. Albans.

The Cable Accessories Co., Ltd., has removed its London offices from Mincing Lane to 15, Charterhouse Street, E.C. 1, where showrooms have been opened. Telephone number, Holborn 5628; telegraphic address, "Revoliteco, Smith, London."

LIGHTING AND POWER NOTES.

Ashton-under-Lyne.—Linking-up.—The Corporation Electricity Committee has had a conference with the Stalybridge, Mossley, Hyde, and Dukinfield Joint Board on the question of electrical interconnection, and representatives of the two authorities are to interview Sir John Snell, Chief Electricity Commissioner, on the subject.

Ayr.—Price Increase.—The pre-war rate for electricity is to be increased by 80 per cent.

Barnsley.—Price Increase.—The T.C. has increased the tariff for electricity for power by another 15 per cent., and for lighting to 7d. per unit.

The Council has declined to allow the Yorkshire E.P. Co. to supply energy to the Strafford Collieries, Ltd., as it can itself afford the necessary supply.

Belfast.—New Station.—On the 11th inst., Field-Marshal Lord French, Lord Lieutenant of Ireland, drove the first pile of the foundations of the new harbour power station, in the presence of a large gathering. Sir James Johnston, ex-Lord Mayor, reviewed the history of electric light and power under the auspices of the Corporation since 1895, the total power then used being about 850, which was increased to 8,500 in 1905, when the tramway system was reconstructed and electrified, and in 1912 to 17,000 h.p. The plans for the new harbour station included provision for 150,000 h.p., and the building scheme when half completed and plant installed, would cost about £650,000. Future requirements could be added from time to time. It was intended to give a wider scope than Belfast to the scheme, under the Electricity (Supply) Act, to extend it to the districts. Provision, he believed, had been made for many years to come. Lord French said that when these works were started, energy was generated at a pressure of 100 volts, now at a pressure of 6,000 volts, and in that space the horse-power had risen from 200 to 20,000. There was hardly an industry where the use of electricity did not mean an increase in the speed of manufacture, and a reduction in the manual labour involved. In these days when the community found itself faced with the problem of overtaking five years' arrears of production, and commenced to solve it by reducing the work week of 47 hours to 44, the necessity for speeding up became obvious. It was in this direction that the application of electricity must be looked to to supply the deficiency. Machines must be multiplied since man power had been reduced. The adaptation and flexibility of electric drive lent itself to this end, and only by its increased application to commercial purposes could we hope to restore to some extent our former national prosperity. Subsequently, at a luncheon, Lord Pirrie said that he was glad to hear of the 50,000 h.p., of which Queen's Island would take 18,000, and they would give his firm another 8,000 before Christmas.

Birkenhead.—Price Increase.—The T.C. has adopted the following new tariff for electricity:—Borough lighting, 6½d., instead of 6d.; maximum demand, 8d., 4½d., and 2½d., against 8d., 4d., and 2d.; out township lighting, 7½d., instead of 7d.; and motive power, borough, first 1,500 units per quarter, 2½d., instead of 2½d.; and 1½d., instead of 1½d., beyond; ditto, out township, 3d., instead of 2¾d.; borough heating and cooking, first 1,500 units per quarter, 2d., instead of 1¾d., and beyond, 1¾d., instead of 1½d.; ditto out township, 2¾d., instead of 2½d.; borough prepayment meters, 6¾d., instead of 6½d.; ditto out township, 7¾d., instead of 7½d.; special consumers, or kw. and miscellaneous rates, 7½ per cent. increase.

Bradford.—Mains Extensions.—The E.C. has authorised extensions of electricity mains, including transformer-chamber equipment, at a total cost of £2,445.

Bristol.—Area Extension.—The E.C. reports that it is of opinion, in view of the changes likely to be brought about in the supply of electricity in the immediate future, and in consequence of applications for supplies which it is constantly receiving from outside the statutory area, that in any Bill which the Corporation may promote in Parliament during the ensuing session, provision should be made for enlarging the area of supply under the Bristol Order, or otherwise enabling the Committee to supply electricity in outside areas.

Buxton.—Price Increase.—The price of electricity is being increased from 6d. to 8d. per unit for lighting purposes, and from 3d. to 3½d. for power.

Carlisle.—Price Increase.—The T.C. has further increased the price of electricity by 20 per cent., making a total pre-war advance of 70 per cent, and to ask consumers under special agreements to pay an additional 7½ per cent. in addition to operation of the coal clause, making a total of 20 per cent.

Expert Advice.—Expert opinion is to be taken with reference to the generation of electricity by water power from the river Eden.

Colchester.—Price Increase.—The T.C. has applied to the B. of T. for an order to increase the price of electricity from 8d. to 10d. per unit.

Continental.—Germany.—The acute coal shortage has driven the authorities to drastic restrictions in the use of gas and electricity. All lighting of shop windows is henceforth strictly forbidden. No shops—except chemists—will be allowed to light up before 9 a.m. and after 6 p.m. No "pictures" are to be shown in the day-time, and at night only between 7 and 10 p.m. In private dwellings lighting must be reduced to one gas burner or alternatively one 50-c.p. or two 32-c.p. electric lamps per room. The working of lifts is to be entirely stopped except in hospitals. Street lighting must not exceed 35 per cent. of the 1913 and 1914 rates. No tramcars must run after 11 p.m.

Bodies of auxiliary technical workmen, capable of keeping vital concerns like gas, water, and electricity works going in case of political strikes, the *Vossische Zeitung* learns, will be established throughout the country. The country will be divided into 19 districts, in each of which a special auxiliary body will be formed, consisting of volunteers, technical experts, engineers, skilled and unskilled workmen. Large numbers have already volunteered.

The electricity works at Zschornewitz, near Bitterfeld, were built in 1915 for the utilisation of the lignite deposits of the district and especially for the electricity supply of the newly-erected nitrogen products works. For more than a year electricity has been transmitted to Berlin through a 110,000-volt line, 132 km. in length; with actual capacity of 180,000 k.v.a., the steam plant ranks among the largest in existence. The chief buildings are the engine house, which has a length of 200 m.; four boiler houses, each 80 m. long, at right angles to the engine house, containing 64 boilers, each of 500 sq. m. heating surface; 11 cooling towers, each of a capacity of 3,800 cb. m. per hour; and 9 chimneys, 100 m. high. The 8 turbo-dynamos give 22,500 k.v.a., at 6,500 volts. The main switches, in a special building, contain the transformers, one for each turbo-dynamo, which steps up the pressure to 82,500 volts for nitrogen fixation and to 110,000 volts for transmission to Berlin; the line ends in the new transformer house of the Berlin electricity works, erected at Rummelsburg, near the metropolis. The line consists of three aluminium wires, 120 sq. mm. in cross-section, which are supported by iron masts 25 m. high, spaced 230 m. apart. The Elbe river is crossed by a span of 307 m. length, carried by towers 60 m. in height; over the River Spree the line is taken by a span of 211 m. length, resting on masts of 48 m. height.

Donegal.—E.L. Scheme.—The C.C. acceded to a request by a deputation from the Letterkenny U.C. that it should not enter into any agreement as to wayleaves for the erection of poles, &c., on the road from Kilmacrenan to Letterkenny Lunatic Asylum, for supplying electricity to the Asylum until the U.C.'s application to the B. of T. for a prov. order authorising the Council to supply electricity, both within and without its district, including the Asylum, has been finally dealt with. Mr. C. A. Flattery, solicitor, who accompanied the deputation, said the only available water-power in the Letterkenny district had been taken by Lord Leitrim for the Donegal Power and Lighting Co., which had secured power, subject to the county surveyor's report, to erect poles on the road indicated; this water-power was also required by the Letterkenny Council. Mr. Philip Carroll objected to the deferring of the grant of wayleaves to the Corporation. Mr. Flattery said the water was on land belonging to Lord Leitrim, and it had been abandoned years ago.

East Lothian.—Fire.—During a severe thunderstorm a fire took place at the electricity station which provides the supply for Thurston Mansion House. The fire is believed to have originated through the building being struck by lighting. The dynamo, switchboards, storage cells, and roof of the building were completely destroyed.

Falmouth.—Proposed Price Increase.—The T.C. has received a letter from the E.S. Corporation, Ltd., asking that its contract might be modified to enable it to increase the maximum charge for lighting purposes from 6d. to 7d. per unit, as allowed by the prov. order. For any further increase above that amount it would have to obtain the sanction of the B. of T.

Grays.—Price Increase.—The U.D.C. has increased the price of electricity for private lighting, as from October 1st, making the war advance 66⅔ per cent.

Harrogate.—Price Increase.—The charges for electricity for all purposes are advanced 50 per cent. on pre-war rates.

Hertford and St. Albans.—Proposed Price Increase.—The North Metropolitan E.P. and D. Co. has applied for the charge for electricity to be altered from 13s. 4d. up to 20 units per quarter, and 8d. beyond, to 16s. 8d. and 10d.

Heywood.—Service Costs.—The Corporation Electricity Committee has decided to charge for all services exceeding 15 ft., or to request the consumer to guarantee a minimum payment for five years to cover the capital charges incurred. The cost of laying 10 ft. of cable is said to be about £10, leaving very little profit.

Price Increase.—The charges for electricity are to be increased by 20 per cent.

Holme.—Water Power.—In the hills which rise from Holmfirth and the Holme Valley there is a quaint electricity generating station. It is part of a novel scheme set up by the villagers to provide themselves with light. The population, including all the people living within a mile or so of the place, is less than 700 souls. The generating station is in a cleft in the hills, where once stood a small wooden mill. Before the mill ceased to exist, some 50 years ago, its looms were driven by a water-wheel, and, in order that power might be obtained from the small mountain stream, a dam was built, and most of the water diverted into a sluice 100 ft. or more above the mill. From here the water flows down a pipe to its natural course directly underneath it, and drives a turbine. The energy is carried up the hill by overhead cables, and down the road to the village. The wooden poles which carry the cables along the road are fitted with one light each. In the village itself there is an auxiliary station, containing another dynamo, and an oil engine to supply power in the event of Rake's dyke temporarily drying up. The stream has not failed during this dry summer, but it did once or twice during the frosts of last winter.

The scheme has been in operation for about three years. The credit for its inception is largely due to Mr. Charles Tinker, a Holmfirth woollen manufacturer who, anxious to obtain light for his house, was the prime mover in the formation of the Holme Electric Co., Ltd. He is the owner of Rake's mill, and, realising its possibilities, he made a gift of the place to the company. A Huddersfield firm carried out the scheme, the cost of which, even in war time, was only about £800. No consumer is bothered by a meter. Each of the 200 or so people who use the light pays 30s. a year for three lights, and 4s. extra for every additional one. The plan works splendidly.

Share holdings in the company are confined strictly to people in the parish, and the concern pays its way comfortably.

Hove.—Housing Scheme.—Referring to the housing scheme now under consideration by the Council, which provides for the erection of 190 houses, the E.L. Committee is prepared to favourably consider a scheme for affording a supply of electricity, providing the M.H. and the B. of T. will sanction the carrying of the necessary mains and services on the overhead system for the sake of economy.

Keswick.—Loan.—The U.D.C. has applied for a loan for installing the E.L. at Whinlatter Hospital.

Nither Wallop (Hants).—Water Power.—E.L. is to be installed at the Parish Church, and energy will be generated at the mill of Mr. Vincent, partly by water power.

Oldbury.—Public Lighting.—The U.D.C. is to consider public lighting by electricity, and to get estimates and comparative particulars.

Plymouth.—Loan.—The E.C. has decided to seek sanction to borrow the sum of £69,750 for the following purposes:—Two boilers, chimney, &c., £20,350; turbo-alternator, switchgear, &c., £28,975; sub-station building extension, £2,900; mains extension, £12,225; converter, £5,300.

Price Increase.—From and after the reading of the meters for the September quarter, 1919, the price of electricity is to be raised by ¼d. per unit for lighting purposes, and by 10 per cent. for purposes other than lighting, and a rental according to scale charged for all meters and the minimum charge for rebate meters fixed at 5s. per quarter.

Swinton and Pendlebury.—Price Increase.—The price of electricity is to be increased by 25 per cent., or 75 per cent. above pre-war rates.

St. Annes.—Loan Refusal.—The recent applications of the Council to borrow £15,000, and the Lytham Council to borrow £35,000, from the purpose of an electricity supply in bulk to Lythan by St. Annes has been refused by the M.H., which, in pointing out the financial loss that would be involved in the scheme, expresses willingness to consider any alternative scheme which might be brought forward. At the Lytham inquiry some time ago, the inspector for the Ministry, Colonel Ekin, pointed out that the cheapest way of supplying the west end of Lytham, at all events, with electricity, would be by extending the St. Annes cable. St. Annes was prepared to do this some years ago, but the Lytham Council refuted the idea.

St. Helens.—Extensions.—The B. of T. is prepared to support the Electricity Committee's proposals for extensions, and it has been resolved that a 5,000-kw. turbo-alternator, auxiliaries, and accessories, be purchased at a cost of £57,960, and application be made to the M.H. for sanction to borrow £57,100 for electricity purposes. The electrical engineer reports that it will be necessary to renew the sections of the old economiser at a cost of £1,440.

Stafford.—Price Revision.—The T.C. has adopted the following new tariff for electricity:—Lighting, up to 700 units per quarter, 7½d.; 700 to 1,400, 7¼d.; 1,400 to 2,000, 7¼d.; 2,000 to 3,000, 7d.; 3,000 to 4,000, 6¾d.; 4,000 to 5,000, 6½d.; beyond, 6d. Power, up to 200 units per quarter, 4½d.; 200 to 1,000, 4d.; 1,000 to 3,000, 3¾d.; 3,000 to 6,000, 3½d.; 6,000 to 10,000, 3d.; 10,000 to 25,000, 2½d.; 25,000 to 50,000, 2¼d.; beyond, 2¼d. There is a discount of 5d. per cent. for prompt payment of accounts.

Sunderland.—Price Revision.—The coal clause at present in force as regards other L.T. consumers is to be applied also to general lighting, domestic heating, and cooking rates, as from the next quarterly reading of the meters, in respect of all increases in the price of coal above 23s. per ton delivered into works' bunkers. Further, that the unit price in the H.T. tariff now current be increased from 0·4d. to 0·5d. The charge for electricity supplied to the Corporation tramways from September 3rd is to be subject to the same coal clause as at present applies to other L.T. consumers for all increases in the price of coal above 23s. per ton delivered into works' bunkers.

Thirsk and Sowerby.—Public Lighting.—The P.C. has asked the Northern Counties E.S. Co. to undertake the public lighting of the district, using the present lamps, the Council taking the risk of accidents owing to the condition of the lamp standards.

Tuam.—Public Lighting.—The Town Commissioners have accepted the tender of the Electric Lighting Co., at £110, for the lighting of the town. Baltina Gas Co. also tendered for the work.

Walsall.—Extensions.—The E.C. proposes to expend £5,921 in extending mains, feeders, and conduits, and in providing transformers and switchgear for giving a supply to new customers; to apply to the M.H. for sanction to borrow the further sum of £44,000 for the following purposes in connection with the electricity undertaking, viz.:—Mains, £38,000; consumers' transformers and switchgear, £5,000; services, £1,000; and also for sanction to borrow the further sum of £11,900 in respect of Birchills power house and external works, such sum being made up as follows:—Buildings, canal intake, &c., £5,320; turbines, switchgear, &c., £1,150; boiler-house plant, £4,850; transformers, £130; switchgear, £450.

Walton-on-Thames.—Proposed Price Increase.—The Urban E.S. Co. is to apply for the charges for electricity to be increased from 8d. to 10d. per unit.

Winchester.—Price Increase.—The T.C. has increased the price of electricity by a further 15 per cent. as from the September meter readings.

TRAMWAY AND RAILWAY NOTES.

Ashton-under-Lyne.—New Track.—The Corporation proposes to lay a double tramway track in place of the single track between Ashton and Bardsley, where the tramways join the Oldham section.

Ayr.—The Town Council is considering the estimated cost of renewing the track from St. Leonard's Church to Newton Station, the sum being £38,400; also doubling the track to Prestwick Toll, and renewing the double track from Newton Station to the car-sheds, £15,500. The engineer of Glasgow Corporation tramways is to report.

Bolton.—Future Development.—The Tramways Committee has appointed a Sub-Committee to consider the future development of the tramways.

Blackpool.—Strike.—After a stoppage of nearly six weeks, the strike of electrical fitters, &c., in the Corporation tramway depôt has been settled. The men's demand for pay on the same basis as fellow craftsmen in Preston area, has been conceded, and work was resumed on September 11th. The settlement means an advance of 2d. per hour on wages paid prior to the strike. The question of back pay has been referred to arbitration.

Bournemouth.—On the 9th inst. Section "G.," Engineering, of the British Association, which met at Bournemouth, in the afternoon, paid a visit to the tramway generating station of the Corporation, where demonstrations were given of electric welding, oxy-acetylene welding and cutting, and the sorbitic treatment of rails *in situ*.

Bradford.—New Cars.—There has recently been a good deal of public condemnation of the local tramway service. Twenty-six new cars and 100 new motors have been recently ordered, and the first new car was dispatched from the builders last week. The chairman of the Committee (Alderman E. Priestley) told the City Council, last week, that 20 cars has been lost completely, and more than 50 others were not available for service. Some at present running, he added, were not "very stable in their movements"; improvement could not be otherwise than slow.

Wages.—Inspectors, linesmen, and telephone men are to be paid 3s. 6d. per week in lieu of payment for overtime, from the date of the last recent award to tramway workers.

The Tramways Committee reported, last week, that it had considered a report with reference to negotiations with the Phœnix Dynamo Manufacturing Co., with the object of securing the removal of the temporary tramway laid through the Thornbury

housing site, and used during the war by the company, under terms of agreement, for conveyance of materials, and that the Committee had instructed the Town Clerk to serve notice on the company, as provided for in the agreement, to determine its use of the tramway.

Canada.—A suggestion has been made by the Municipal Board of Control, Toronto, to establish municipal works for the manufacture of tramcars, in view of the fact that the city proposes to acquire the tramcar system which is now operated by a company whose franchise expires in 1921. The following opinion of a Sub-Committee of a Municipal Transport Commission has been given to the Commission :—"It would not be prudent for the city to embark on the manufacture of street cars. The investment entailed would be so extensive as to burden tramway operation with large overhead charges which would seriously affect the economical administration of the system. After the primary needs of the consolidated tramways are met, the number of new cars required annually would not be sufficient to justify the maintenance of such a factory. Indeed, on this Continent, it was found by operating companies, almost without exception, most advantageous to purchase their requirements from the comparatively few manufacturers who specialise in tramway-car production." The municipal officials have recommended that the city should purchase its tramcars from concerns manufacturing them, instead of constructing its own cars. British firms interested in this matter, says the *Board of Trade Journal*, should communicate with Mr. R. C. Harris, Commissioner of Works, City Hall, Toronto.

Continental.—SWEDEN.—According to *Tidens Tegn*, of Christiania, the Swedish Minister will make next year, to the Swedish Parliament, an application for a credit of 90,000,000 kroner, in order to electrify the Stockholm to Gothenburg railway. The line will have a length of 458 km. The electric power required for this service is put at 30,000 KW., half of which will be drawn from the Trollhattan Falls; 14 transformer stations are included in the scheme. So soon as the credit is voted, work will be begun, and is expected to last three years. Speed up to 80 km. per hour is expected to be realised eventually on this line. The scheme has special interest in that it forms part of the work contemplated to create a great international traffic highway between Europe and Russia by way of Finland, and so compete with the German lines.

ITALY.—There has been formed at Varese the Società Prealpina di Trasporti for the acquisition and working of the Menaggio to Porlezza Railway, and its conversion to electric traction. The capital of the undertaking is 750,000 lire.

SWITZERLAND.—The Swiss State Railways Administration has approved the scheme for the electric conversion of the Erstfeld-Lucerne, Arth-Goldau-Zurich, Zug-Lucerne, and the Immensee-Rothkrenz lines (together 141 km.) at a cost of 43,500,000 fr. A credit of 37,500,000 fr. has also been voted for the Barberine central in the Canton of Wallis, which will supply energy to the West Switzerland lines. The programme of the work is as follows :—Erstfeld-Bellinzona, 109 km., to be opened in 1920; Bellinzona-Chiasso, 55 km., to be opened in 1921; Erstfeld-Lucerne, 60 km., to be opened in 1921; Arth-Goldau-Zurich, 45 km.; Zug-Lucerne, 28 km.; Immensee-Rothkreuz, 8 km.; Rothkreuz-Rupperswill, 40 km.; Rupperswill-Aarau, 6 km.; and Aarau-Olten, 18 km.—all six to be opened in 1922. The line Lurcerne-Olten-Basel will be opened in 1924. Transformer sub-stations are planned at Steinen and Thalwill. Between Amsteg and Steinen the H.T. current will be carried underground by 120 sq. mm. cable, so as not to disfigure the landscape.

FRANCE.—The tramway workers at Marseilles, on Friday last week, decided on a 24-hours' strike. The seamen and gas works' employés were also on strike.

Egypt.—STRIKE.—The Cairo tramway strikers have offered to resume work if they are paid for the strike period, and receive an immediate advance and a promise of favourable consideration of their demands in a month's time.

The Alexandria tramway workers have struck work on the eve of the festival of Bairam, when their services are most required. Newspapers advocate pressure on the Government to induce it to take a strong line.

Exeter.—ELECTRIC VEHICLES.—The City Council will adopt electrically-propelled vehicles in lieu of horse traction for the purpose of collecting house refuse. Five Edison 2-ton vehicles are to be obtained, at a cost of £1,304 per vehicle; a generator and switchboard, at an estimated cost of £500; and a garage, £2,342. It is estimated that this mode of collection will save £1,900.

Huddersfield.—ACCIDENT.—On September 12th a motor-wagon in attempting to get ahead of a tramcar going in the same direction, got jammed between it and a car coming the opposite way. There were two ladies besides the driver in the motor-wagon, and all received severe injuries, the driver in particular. Both cars were badly smashed in front, and the motor was lifted off the ground by the force of the collision. The accident caused a delay in the tramway service for a time.

London.—Traffic on the London and South-Western Railway was upset at noon on Friday last week, when a bullock rushed from the Nine Elms depôt up the line. Receiving slight shocks from the live rail, he became wild and had almost reached Clapham Junction before he fell on the live rail and was killed. The current had to be cut off while the animal was removed, causing delay of half an hour to traffic on the electric system.

An L.U.T. tramcar was derailed at Kew Bridge on Friday evening last week, and traffic on both lines was held up for some time.

Through an engine breaking down, traffic on the G.N. electric line from Finsbury Park to Moorgate Street was delayed.

At 8.30 on Saturday evening a water main burst in the High Street, Wandsworth. At 10 o'clock on Sunday morning a gas main burst, and half an hour later a main electric cable supplying the L.C.C. tramways, fused and set fire to the escaping gas. The fire was quickly subdued, but the High Street was blocked, and the tramway service held up.

The axle of a tramcar broke, during the rush hour, in Kennington Park Road early on Tuesday, and traffic had to be diverted. Two tramcars collided at the junction of Vassal Road and Brixton Road, and three injured lady passengers were taken to hospital.

Oldham.—ELECTRICITY CHARGES.—The Tramways Committee is asking the Electricity Committee to reconsider the charges made to the tramways, as it contends it is paying more for energy than are other authorities.

Sheffield.—STRIKE.—Early on the morning of September 11th the tramway employés decided on an immediate stoppage of the service. Strike pickets were posted, and no cars were allowed to leave the sheds. The week's notice given by the men expired at midnight on September 10th. They demand 2s. per hour, which is more than the 12s. increase asked for by the National Federation, and an overtime rate of time-and-a-half for all grades of Sunday workers. The Tramway Committee offered to concede the Sunday overtime rate, but stipulated that it would be paid only to employés after completing a year's service, but the men demand payment without any distinction as to length of service.

The strike spread to Mexbro' and Swinton, where the employés of the local tramway company declared a stoppage on Saturday morning. Thus the three linked-up systems, Sheffield, Rotherham, and Mexbro' were idle. A deputation of strikers met the tramway authorities on Saturday, and it was afterwards intimated that the chairman of the Tramways Committee had promised to bring the deputation before the Committee at an early meeting. A demonstration by the strikers was held on Saturday, but little public sympathy was evinced.

The men acted against the orders of the National Federation in declining to wait for arbitration.

The strike ended on Tuesday night, the men agreeing to resume work, provided that all strikers were reinstated immediately.

Wages Dispute.—The tramway workers' claim for increased wages entered on a fresh phase on the 15th inst., when a preliminary meeting was held by the Court of Arbitration at Old Palace Yard, Westminster, to discuss the procedure to be adopted in the arbitration inquiry already agreed upon between the parties.

On the employers' side the following bodies were represented : The Municipal Tramways Association, the Tramways and Light Railways Association, and the London General Omnibus Co.; while the employés were represented by the Negotiating Committee of the National Transport Workers' Federation and the secretary (Mr. R. Williams). The Arbitration Committee consisted of Sir William Mackenzie, Colonel Denny, and Mr. Button. A two hours' discussion on procedure took place, both sides being heard. Arrangements were made for the arbitration proceedings to be opened on the 23rd in London, at which all parties will be able to appear and give evidence. It is learned that the arbitration will be national in scope and character, and that the evidence will probably be taken at one centre in London. At present it is unlikely that there will be a number of district inquiries.

TELEGRAPH AND TELEPHONE NOTES.

Aircraft Wireless.—In connection with the granting of temporary provisional authority for the installation and use of wireless apparatus in aircraft, as announced in our last issue, the Air Ministry makes the following announcement :—For the present the wave length suggested for wireless telephony is 480 metres. This is the wave length which the existing Air Ministry wireless telegraph stations at present employ for work with aircraft. The announcement gives particulars of the provisions which will probably be found in the Postmaster-General's licence. The sending apparatus installed at any aircraft station shall be capable of using waves of 600 metres interrupted continuous wave, and 900 metres continuous wave; 220, 300, 450, and 800 metres interrupted continuous wave, and 200-550, 650-950, 2,000-3,000 metres continuous wave may also be used for transmission when authorised by the Postmaster-General. Should an aircraft station be also fitted with a supplementary installation on long continuous waves, this shall be capable of using the wave length of 2,400 metres. The range of wave lengths for which the receiving apparatus may be constructed is not limited, but the apparatus must be capable of receiving on 600 metres and 900 metres, and on 2,400 metres when a transmitter working on this latter wave length is installed.

During the recent Continental trip of the British airship R 33, by special arrangement with the Marconi wireless station at Wormwood Scrubbs a complete summary of the news of the day was dispatched to the airship from the *Times* office. The last sentence of the summary was received by the airship about 4 a.m. on the morning of the 11th inst, whilst she was flying at a height of 4,000 ft. over the North Sea, and the passengers at breakfast two hours later each received a copy.

Egypt.—A Colonial representative of a British firm, writing to the *Evening News* from Alexandria, Egypt, draws attention to the telephone facilities in that country. He had, the writer states, in his rooms on August 30th last, at his hotel, at different times five buyers of English goods that he was selling. Their nationalities were, respectively, Italian, Greek, French, Egyptian and Syrian. They all found it necessary to telephone to their respective premises, and the writer made a note of the times taken to reply. Each spoke in his own language when asking for the number, and in no case did the connection take more than 15 seconds! The writer rang a number himself later, and was answered in fairly good English that the number was engaged, but that the operator would put him through as soon as it was free. He waited 90 seconds, the bell rang, and he was through, after receiving an apology from the operator for being kept waiting! Having made inquiries, the writer adds that he finds the average age of the operators (girls) is 18 years; installation is practically immediate, and although the instruments have to be imported, the service is much cheaper than in England. It is a condition that all operators must be conversant with at least four languages before being employed, although the joining age is 16 years.

Ireland.—It is reported from Dublin that the Post Office telephone and telegraph wires were cut by Sinn Feiners on the 14th inst., at Rockenham, West Cork. Inconvenience was caused in the district of Monkstown and other places, cut off from direct communication with Cork.

Malta.—The postal and cable censorship will be removed in Malta, as from September 15th.

Switzerland. — The Federal Council has approved a Bill increasing the telephone and telegraph charges.

Telephone Delay.—The telephone service at Fleetwood was in such a state of congestion last week, that merchants wired to the district manager at Preston offering to pay his expenses if he would travel to Fleetwood by aeroplane to ascertain first hand the state of the service. He did not avail himself of the offer.

The Marconi Co.—It is understood, says the *Sunday Evening Telegram*, that the parent company has sold its entire interest in the American subsidiary on very good terms to the General Electric Co., of New York. A new company will be formed, and it is probable that the existing shareholders of the American Marconi Co. will be given an opportunity to exchange into it on attractive terms.

The Telephone Service.—According to the *Times*, the Postmaster-General (Mr. Illingworth) has consented to receive a deputation, on October 2nd, from the National Union of Manufacturers on the subject of the telephone service.

Wireless to Ships.—Marconi's Wireless Telegraph Co. announces that long-distance messages can again be accepted for transmission through its high-power wireless station at Poldhu, to ships which are not within range of any other British coast station. The Poldhu station communicates with ships at night only and its range is about 1,500 miles. The address of radio-telegrams for transmission by this service must include (1) the name of the addressee; (2) name of the ship; (3) "Poldhu." Messages should be handed in at any postal telegraph office in the United Kingdom, or at the company's offices; the rate per word being 2s. 10d.

CONTRACTS OPEN AND CLOSED.

(The date given in parentheses at the end of the paragraph indicates the issue of the ELECTRICAL REVIEW *in which the "Official Notice" appeared.)*

OPEN.

Australia.—SYDNEY.—November 10th. City Council. Supply of electric motors. Particulars from Electric Lighting Department, Town Hall, Sydney.

October 13th. City Council. Three 2,000-K.V.A., 33,000/5,000-volt, transformers. Electric Lighting Department, Town Hall, Sydney.

December 19th.—Metropolitan Board of Water Supply & Sewerage. Centrifugal pumps, electric motors, &c., for the low-level pumping station, Marrickville. Offices of the Board, 341, Pitt Street, Sydney.*

MELBOURNE. — P.M.G.'s Department. January 20th, 1920. Automatic switchboard at Collingwood. Schedule 1,583. (See this issue.)

Bradford.—October 9th. Electricity Department. Two 1,500-KW. rotary converters, transformers, &c; induced draught plant and chimneys, and three economisers. (September 12th.)

Dundee.—October 8th. Electricity Department. E.H.T. switchgear and concrete cell-work at the Carolina Port Main generating station. Section "A," switchgear for one 5,000-KW. turbo-generator and six feeders; section "B," alterations and additions to present switchgear, for two 5,000-KW. turbo-generators, one feeder and one 500-KW. transformer. (See this issue.)

Grimsby.—September 25th. Electricity Department. Two 1,000-KW. converters and D.C. and A.C., L.T. switchgear; E.H.T. switchgear and cubicles; coal and ash-handling plant; 30-ton electrically-driven travelling crane. (August 22nd.)

India.—LAHORE.—Electric Supply Co. Generating plant, two 1,000-KW. and two 500-KW., three-phase, 6,600-volt turbo-alternators, &c.; boilers, mechanical stokers, &c.; sub-station plant, H.T. and L.T. mains, &c. (Specifications available October 1st.) (September 5th.)

Madagascar.—March 1st, 1920. Directeur des Travaux Publics à Tananive. Installation of electric station, with equipment, at Falls of Volobe, near Tamatave; erection of overhead transmission and distribution lines, and establishment of service in the city. Ministère des Colonies, Paris.

Manchester.—September 23rd. Electricity Department. Two 250-K.V.A., three-phase, static transformers; two 500-K.V.A. ditto. Mr. F. E. Hughes, Secretary, Electricity Department, Town Hall, Manchester.

September 22nd. B. of G. Electric lamps for 12 months. J. MacDonald, Clerk to B. of G., Union Offices, All Saints, Manchester.

Paris.—October 6th. Administration des Chemins de Fer de l'Etat. Electrical and mechanical equipment for the extension to the Rouen generating station. Bureaux du Service électrique (I. division), 43, Rue de Rome, Paris.

New Zealand.—NAPIER.—September 30th. B.C. Tramway rails, points, crossing, special trackwork, &c.; trolley, test and span wires; tramway poles and sleepers. Town Clerk, Borough Council, Napier.*

South Africa.—WORCESTER (CAPE PROVINCE).—Tenders are being invited in connection with the extension of the power station and the installation of additional plant.

St. Helens.—October 4th. Electricity Committee. One 5,000-KW. steam turbine, with condensing plant and auxiliaries. (See this issue.)

Warrington. — October 7th. Electricity Committee. H.T. and L.T. lead-covered cable. (See this issue.)

West Ham.—September 23rd. Electricity Department. One 1,000-KW. turbo-alternator, one 10,000-KW. surface condensing plant, two water-tube boilers, superheaters and stokers. (September 12th.

*A copy can be seen at the Inquiry Office of the Department of Overseas Trade (Development and Intelligence), London.

CLOSED.

Australia.—Prahran and Malvern Tramways:—
100 sets air brakes, £18,881.—British Westinghouse E. & M. Co., Ltd.
—*Melbourne Age.*

Bradford.—Electricity Committee:—
Three water-tube boilers, superheaters and mechanical stokers.—Babcock and Wilcox, Ltd.
Cooling tower and chimney for cooling stack.—Peter Brotherhood, Ltd.

Glasgow.—Electricity Committee:—
Cranes for sub-stations, £4,738.—Sir Wm. Arrol & Co., Ltd.

Oldbury.—U.D.C.:—
Restoring electrical system at the sewage disposal works.—Shropshire, Worcestershire & Staffordshire E.P. Co.
Electric blower.—Bryan Donkin Co., Ltd.
Motors.—General Electric Co.
Stereophagus pump.—Pulsometer Co.

FORTHCOMING EVENTS.

Iron and Steel Institute.—Friday, September 19th. At the Institution of Civil Engineers, Great George Street, S.W. 1. At 10.30 a.m. Autumn meeting.

Junior Institution of Engineers.—Saturday, September 20th. Visit to the National Physical Laboratory, Teddington. Meet at Teddington Station (L. & S.W. Railway), 2·45 p.m.

Institute of Metals. — Wednesday, September 24th, and Thursday, September 25th, at Sheffield. Annual Conference.

Shipping, Engineering and Machinery Exhibition.—September 25th to October 17th. At Olympia, West Kensington, W.

NOTES.

Alteration in Time of Publication of the "Electrical Review."—As the result of recent changes in the arrangements for printing the ELECTRICAL REVIEW, due to new terms adopted in the printing trades and to the rapidly expanding increase in the circulation of the journal, it has been necessary to defer publication until Friday afternoon. We very much regret the necessity of this alteration, involving a departure from the established practice of very many years, but the new conditions leave us no option. The journal will in future be on sale in London at 4 p.m. on Fridays; copies sent by post or obtained through local agents will reach the hands of subscribers on Saturday mornings.

West Midlands District (Whitley) Council. — The secretary of the City of Birmingham Electricity Supply Department informs us that at a conference in Birmingham on Monday last (convened by the Lord Mayor) of representatives of electricity supply undertakings and of trade unions concerned, it was unanimously decided to take steps forthwith for the setting-up of a District (Whitley) Council for the electricity supply industry for the West Midland area, comprising the counties of Shropshire, Stafford, Warwick, and Worcester. A small committee consisting of three representatives from either side was elected to draw up a constitution, and steps were taken for subsequent separate meetings of employers' and employés' representatives respectively, to determine the method of election of members of such District Council, and the subsequent joint meeting of both sides to bring the District Council into being.

The Federation of Technical and Scientific Professional Associations.—A meeting of the Federation of Technical and Scientific Associations was held in London on the 6th inst., to which kindred associations had been invited to send representatives. Fourteen associations were present, representing the interests of about 50,000 professional officers and servants. The meeting was presided over by Mr. A. C. J. Charlier, the president of the Federation. The draft proposals for the constitution of the Federation were considered, and many useful suggestions were adopted. It was agreed that all duly qualified bodies which accepted the constitution and adhered to the Federation by the date of the next meeting, viz., October 18th, 1919, should be considered original members of the Federation. It was also decided to form a Group Committee for each professional interest represented, to advise the Federal Council. At the conclusion of the meeting, the representatives of the British Association of Chemists announced their intention of joining the Federation, and Mr. N. Wyld intimated that the Society of Technical Engineers would probably become a member.

Feasibility of 220,000-Volt Transmission.—The results of a detailed investigation to determine whether 220,000-volt transmission is economically and technically feasible in the near future were presented quite fully in the June 28th issue of *Electrical World*. The opinion there expressed by Mr. A. E. Silver of the Electric Bond and Share Co., was that such high-voltage transmission is immediately possible. In this belief he was supported by numerous speakers at the Lake Placid convention of the A.I.E.E. during the same week, where the paper was presented, although certain problems which are not fully solved were pointed out and attention called to further research that is necessary to meet the requirements of such transmission in the best manner. A concrete opportunity for application of this high voltage was cited by Mr. W. S. Murray, formerly electrical engineer of the New Haven Railroad and conservation engineer for the Government, who referred to a super-power line which is proposed between Washington and Boston to serve a territory measuring about 450 miles (724 km.) long by 150 miles (241 km.) wide. In considering the paper, several speakers expressed themselves in favour of the earthed Y-connection, questioned the advisability of eliminating line protection entirely, and raised objections to high-tension switching. Others questioned the advisability of eliminating spare transformers, suggested the use of link insulators instead of cement-and-pin type, expressed the opinion that use of 15 disks in series on an earthed line is unduly conservative, and mentioned factors that become important at high voltages. Operation of 220,000-volt transmission lines without spare transformers is considered unwise by Mr. A. F. Bang, Pennsylvania Water Power Co., Holtwood, Pa., who favours single-phase transformers in preference to large three-phase transformers for this service. He also questioned whether external cooling of transformers was justified in every case. Mr. F. W. Peek, Junr., expressed the belief that a line built according to the plan outlined in Mr. Silver's paper would be more reliable than present 33,000-volt lines, and that link-type insulators would overcome most objections to insulators, since they show very little depreciation even when made of poor porcelain. Several factors which are of no consequence at low potentials become serious in the design of high-voltage apparatus, pointed out Mr. J. F. Peters, Westinghouse E. & M. Co., one of them being the electrostatic field. Short-circuit stresses will not be so severe on high-tension transformers because of the greater magnetic leakage. Some difficulties will be involved in transporting and handling the apparatus in sizes such as will be required. While some speakers inferred that there might be less insulation on the earthed end of Y-connected transformers, Mr. Peters pointed out that there should not be less insulation between turns, because just as great if not higher voltage is impressed there.

Electric Vehicles.—In the July issue of the *Electric Vehicle* Mr. J. W. Beauchamp, director of the E.D.A., discusses the advantage of the electric vehicle. For the moment, he says, it seems desirable that manufacturers and the supply undertakings should consider the question of letting out vehicles on trial to possible customers. Such trials would bring home as nothing else could the advantages and economy to be achieved in the running of an electric for certain classes of work. One of the chief difficulties in pushing the electric vehicle at the present time is the apparent high first cost, yet the most effective canvassing consists in the loan of a vehicle with an accomplished and obliging driver who would endeavour to get the best out of it and show to the borrower its full possibilities and advantages. It would appear that electric vehicles to-day are principally employed by a comparatively limited number of large organisations which have rapidly acquired considerable fleets of the vehicles. The man who only requires one or two has not been exploited sufficiently as yet.

Magneto Developments. — The *Revue générale de l'Electricité* of July 5th describes French patent No. 487,287, of Brown, Boveri & Co., of a magneto in which the coil and magnets are fixed. The variation of the magnetic flux is effected by rotating an armature, consisting of laminated iron, between the poles of the magnet. Sketches are given. French patent No. 484,580, of E. Malivert, relates to an arrangement by which the maximum spark may be obtained for any advance or retardation of the sparking. In the usual construction the adjustment of the timing of the spark causes the break to take place before or after the time at which the maximum spark would be produced. In the design now described, the poles of the magneto are embedded in a cylindrical frame of non-magnetic material—slotted to avoid eddy currents—and may be rotated so that the poles take up a position depending on the advance or retardation of the spark. By this means the break always takes place in the best position for obtaining a good spark.

Detecting Overheated Bearings.—Certain double iodides of mercury with other metals are dimorphic and exhibit a more or less pronounced colour change at the transition point. H. T. Pinnock has made a study of these in order to determine which compounds are most suitable for use as visible indicators of overheating in bearings and machinery.

The double iodide of silver and mercury, $AgI.HgI_2$, is a pale lemon yellow powder at ordinary temperatures, but changes to a vivid carmine at 90 to 100 deg. C., the change in both directions being fairly sharp. With copper mercuric iodide, $Cu_2I_2.2HgI_2$, the change from a vivid scarlet vermilion to a chocolate brown takes place at 60 to 70 deg. C. It was found that a mixture of the two, consisting of 85 per cent. of the copper salt and 15 per cent. of the silver salt, was more sensitive and gave an exceedingly sharp transition from vermilion to almost black at 60 to 70 deg. C.

For application to bearings, &c., these compounds are mixed with white shellac spirit varnish, or, for higher temperatures, a medium such as is used in aluminium paints for steam pipes, in the proportion of 100 g. compound to 70 cc. of medium. This paint is best applied as a bull's-eye or band on a zinc-white background. After the paint is dry, it should be protected with a coat of colourless oilproof varnish.—*Chem. and Met. Engineering.*

Cast Rotor Windings for Squirrel-cage Motors.—Casting the bars and short-circuiting rings which comprise the induction-motor rotor windings in one operation is the radical development now being applied by one motor manufacturer. This cast winding ensures uniform cross-section, and perfect union between the bars and end rings, thus ending previous operating difficulties that arose from their opening. Better balance, greater rigidity, and increased durability are also obtained by this new process.

Ventilation for either direction of rotation is obtained by means of a series of holes bored radially through the cast end rings. Freedom from blow-holes and other imperfections is secured through spiral casting and machining methods.

The method of casting the rotor winding is particularly interesting because it is done in place. That is, the stripped rotor serves as the mould in which the bars are cast, thus simplifying construction and minimising expenses.—*Electrical World.*

The Electrical Development Association.—Since the beginning of this month the Management Committee has sent out formal invitations to electricity supply undertakers and to manufacturers and contractors, inviting them to become subscribing members of the Association, and has received a very large number of replies of a satisfactory and encouraging nature from some of the largest, as well as the smallest, undertakings in the industry. Although a great deal of preliminary work has had to be done in formulating the articles of association and preparing a working organisation, the activities of the staff have not been concentrated on this work to the exclusion of all else; on the contrary, a very substantial amount of spade work has been accomplished, and a valuable goodwill established, so that "E.D.A." is in a position to offer immediate results to contributors. Many readers will, no doubt, imagine that "E.D.A." may be a very estimable institution, and all that, but that she—or it—can be of no possible use to *them*; let them disabuse themselves of this idea, and write to the director, Mr. J. W. Beauchamp; we are confident that he will demonstrate the contrary to their satisfaction.

A Magnetic Sclerometer on Loan.—The new magnetic sclerometer has aroused great interest among the Universities and technical schools, and Messrs. Automatic and Electric Furnaces, Ltd., have received many applications for the loan of an instrument. They have, therefore, decided to lend an apparatus, complete with samples of different steels having varying heat treatments, for short periods, for purposes of demonstration, to recognised educational authorities upon receipt of an application from principals or senior demonstrators.

Baking Bread Electrically.—A French electrical journal gives information, says *Engineering*, on the progress recently made in Switzerland in the installation of electrically-heated bread baking ovens, the energy being furnished by water power. It quotes the following :—For baking 100 kg. of bread, the coal consumption in ordinary ovens is from 35 to 50 kg., and 16 kg. in the large steam-heated ovens. The electrical energy required for baking the same quantity is from 45 to 50 KW.-hours. The *Journal of Electricity* also gives some results of recent tests on a large oven installed by the Haynes Foster Baking Co. (Inc.), of Portland, Oregon, this being the largest electrical installation of its kind west of Salt Lake City. The oven referred to is a Hughes continuous baking oven with a capacity of 650 12-oz. loaves. The electrical power used is A.C. 220-volt, three-phase, 60-cycle, and the total current that can be used at any one time is 210 amperes, the heating elements being balanced between the three phases. The heating units consist of 6-heat units, each divided into three separate sections, with each section controlled by a 3-heat snap switch. The temperature used is from 400 to 500° F. The results of the tests are given in the following tables :—

FIRST TEST.

Date.	Hours' operation.	KW-hours.	Loaves 12 oz.	Average KW.-hours per hour.	Average loaves per hour.	Average KW.-hours per loaves.
Oct. 7th	11¾	588	9,834	50	837	59·8
„ 8th	117	657	9,911	59·7	901	66·3
„ 9th	9	570	7,483	63·3	832	76
„ 13th	14½	1,024	13,286	71·9	932	77
Total 4 days	46	2,839	40,514	61·7	881	70
Daily average	11·5	710	10,128			

SECOND TEST.

Oct. 23rd	8½	545	8,671	64	1,020	62·8
„ 24th	12¼	735	10,314	60	842	71·2
„ 25th	10	653	9,688	65·3	969	67·4
Daily average	10¼	644	9,558	—	—	67·4

Expansion of the Telephone System.—The progress made in extending the telephone system to country villages in the years 1912, 1913, and 1914, resulted, according to the *T. & T. Journal*, altogether in the opening of 453 exchanges in those three years, although the year 1912 was devoted rather to the closing of duplicate National Exchanges and the transferring of others to Post Office premises than to opening new ones. A like development during four years of war will not be expected, yet it is interesting to note that 176 new exchanges were opened in small country places during that period, viz., 95 in 1915 ; 13 in 1916 ; 9 in 1917 ; and 59 in 1918 ; or 96 in England and Wales, 10 in Scotland, and 70 in Ireland. The respectable figure for 1915 is probably due to the completion of schemes which were mostly well under way when the war broke out, and the total for 1918 is due to a certain telephonic activity in the West of Ireland ; for, of course, the work of developing new ground was not pursued in times when the expansion of existing exchanges was almost limited to the utilisation of spare plant and to orders connected with war work. The telephone system reaches every county in England and Scotland with the exception of the Orkneys and Sutherlandshire, which are still without an exchange ; and in Ireland with the exception of Mayo, Leitrim, and Roscommon. The service has now been extended to Longford, and as Athlone is partly in Roscommon it cannot be said that that county is entirely without the telephone. The counties in which the largest number of exchanges were opened in the period under review were Yorkshire with 9, Cork and Limerick 8 each, Essex 7, West Meath 6, Kent, Lincoln, Lancashire, Dorset, Kerry, Cavan, and Tipperary 5 each.

Colliery Manager Prosecuted.—At Hamilton Sheriff Court, John McBride, Broomside, Manse Road, Motherwell, was charged with contravention of the Coal Mines Act. It was alleged that respondent, being manager of Dalzell and Broomside Colliery, failed to carry out and to enforce to the best of his ability, certain provisions of the Coal Mines Act relating to explosives, propping, the providing of refuge holes, and the construction and protection of electrical apparatus. It was alleged that in a section of the Blackband seam a certain portion of the electrical apparatus was not so constructed, installed, and protected, as to prevent danger, and that there was failure to have properly constructed bushes to prevent the abrasion of cables. Objections raised to the relevancy of the complaints, were repelled by the Sheriff, and a plea of "Not guilty" having been submitted, the trial was fixed to take place provisionally on October 1st.

The Institute of Metals.—On Wednesday and Thursday next, September 24th and 25th, the Conference of the Institute will be held at Sheffield ; it will be the largest on record, comprising 400 representative metallurgists and engineers from every part of the British Isles, as well as the United States, Sweden, France, &c., one-fifth of the entire membership (1,200) being resident abroad. A souvenir booklet to be issued in connection with the meeting will give a list of members present, the revised programme (which now includes a kinematograph display of brass-melting in the electric furnace), particulars of local works and products, and a map of Sheffield.

Summer Time.—Summer time will end on the night of Sunday-Monday, September 28th-29th, when Greenwich time will be reverted to.

Reviving Plants with Electricity.—Some account of a florist's experiments in reviving weak or stunted plants by the application of low-voltage direct current is given in *Science Siftings*. One of the experiments was tried on a small cactus plant which had been sent from Mexico, and which seemed to pine away rapidly. The cactus appeared to be nearly dead when the experiment was first tried. Two cells of a dry battery were used, the positive pole being connected to a nail placed in the soil of the flower pot, and the negative secured to the upper part of the plant. The cactus brightened up after one week's treatment, and in two weeks was growing nicely. Further experiments were tried on rose and fuchsia bushes with good results, care being taken to see that the positive pole was always applied to the root, and the negative to the foliage of the plant. The resistance of a plant is considerable, so that the flow of current is but a fraction of an ampere ; if an accumulator is used the current should, therefore, be suitably regulated. Several other experiments were tried, notably on a plum tree, which was treated with six cells, with the result, it is stated, that the tree blossomed out fully several days ahead of the others adjacent. Also an "ever-bearing" strawberry plant was treated with two dry cells. This plant was left in the same row with other berry plants, and its increased size and fruit production is said to be striking.

Educational.—BATTERSEA POLYTECHNIC, S.W. 11.—The next session commences for day courses on September 23rd, and evening courses September 29th. Mr. A. T. Dover, M.I.E.E., is head of the electrical engineering department. Abridged calendar of evening classes can be obtained gratis on application to the Secretary. See our advertisement pages to-day.

Appointments Vacant.—Instructor in electrical maintenance (£250—£300) for the Willesden Polytechnic ; instructor in electrical wiring and installation work for the Northampton Polytechnic Institute ; shift engineer for the Bournemouth Corporation tramways ; shift engineer (82s. 6d.) for the Redditch U.D.C. electricity works. See our advertisement pages to-day.

Magnetic Storm.—South Africa felt the effects of the electric storm which occurred on August 11th and 12th, and was reported in our pages at the time. The storm was first observed on the telegraph lines of the Union between Cape Town and Beaufort West in the early hours of the Monday morning, and was the cause of the heavy delay in telegraphic messages on the Monday and Tuesday. Earth currents varying continuously in direction and intensity frequently neutralised currents up to 80 volts totally stopping communication on local lines in addition to train lines to the north-north-west and eastwards. The greatest intensity was observed to be over Cape Town during the forenoon. The storm decreased in intensity after 5 p.m., but strengthened later in the evening up to 65 volts, and was then observed to be almost as strong on northern and eastern lines beyond Beaufort West. The currents were also observed in Graaff-Reinet district up to 40 volts and continued throughout the night. The earth currents were somewhat weaker on the Tuesday, but with quicker variations between Cape Town and Beaufort West, changing direction from north to south and south to north, and curtailing the working of the lines to one direction instead of duplex. The currents were not now so noticeable on the north and eastern side of Beaufort West and gradually weakened, and practically disappeared by 4 p.m. Two fairly large and one group of small spots were seen on the sun at Beaufort West.—*Cape Times.*

Electrical Precipitation of Tar Fog.—According to a communication presented by G. Davidson to the Canadian Mining Institute (*Transactions*, 1918, pages 252-258) the Cottrell process of electrical precipitation is quite able to deal with the crude gases produced in the distillation of coal, wood and petroleum, even at the high temperatures used in modern industrial processes, whilst the usual methods of tar fog removal in extractors require cooling of the gases. Davidson obtained cleaner distillates with electric precipitation than formerly. The treater chamber he used coosisted of an iron pipe, 15 ft. high and 12 in. in diameter, provided with fused quartz insulators ; he passed about a million cb. ft. of gas through his heater per day, and the heater requires about 2 H.P. or 3 H.P.

An Electric Tool-Tempering Furnace.—An electric tool-tempering furnace, using the barium-chloride and salt principle, says *Engineering*, is proving highly successful in the South Philadelphia works of the Westinghouse E. & M. Co. The chief advantages of this type of furnace over those using other fuels are constancy and ease of control of heat, cleanliness, equal heating of each atom of the specific part of the tool to be tempered, low cost of operation and excellence of the finished work. The furnace consists of an outer shell, a cast-iron cylinder packed with firebrick, and an occasional layer of asbestos. The heat is supplied by two pairs of electrodes built in on opposite sides of the walls of the inner chamber. The electrodes operate on a 16 to 30-volt A.C. circuit. Carbon sticks are placed between the electrodes in the chamber to complete the circuit. The current is started on the 30-volt circuit. Salt is fed in, when it is melted it completes the circuit, and the carbon sticks are removed. A mixture of barium-chloride is then fed in, the final preparation being about 60 per cent. of barium-chloride. When the temperature of the liquid reaches 1,425° F. the voltage is lowered. The current regulation at the switchboard gives a quick and easy method of control, and the liquid, kept at one temperature, heats the tool uniformly from surface to centre. The furnace throws off very little heat, a feature appreciated by the workmen.

Electrical Undertakings in China.—The total undertakings in China at present, according to the *Jiji Shimpo*, is 168, and of these the number under "foreign" management is 49. Foreigners, states this authority, are under a disadvantage of being unable to do business in China generally under their own names, and money is therefore invested by them in the shape of loans to Chinese corporations. Through the South Manchurian Railway, Japan has invested 203,500,000 yen, and through other concerns 1,555,000 yen. British subjects have invested 21,000,000 yen in their own names, and 22,000,000 yen through Chinese concerns.

Canton.—Canton Province shows the largest number of electrical concerns, the number of undertakings being 23. One of these is the British Tramway Co. The remainder are power and light companies, of which 18 are Chinese, three are British, and one Portuguese. The total amount of electricity supplied for power and light is 10,345 KW., and 800 for the tramways. The total number of lamps is given at 3,000,000. The principal sources of power are gas and oil, steam power being only used by two concerns. No water power is used. The general capacity of companies is small, as only four concerns generate over 1,000 KW. or more.

Kiangsu.—The number of electrical concerns in Kiangsu is 22; of these 19 are power and light companies, two tramway companies, and one, a French company, having a capital of 8,000,000 francs, and operating in the French Concession, Shanghai. The majority of these companies are Chinese, two only being British. The power developed in this province is considerably in excess of that in Canton, though the number of concerns is smaller, figures being as follows:—

	KW.
Power generated by power and light concerns ...	24,158
Power generated by tramway companies	1,450
Amount produced by the French combined concern	1,500
Lamps lighted, about	900,000

Steam power is universally used. The Shanghai Electric Tramway Co. is under British management, and its capital is £388,000.

Shengking.—It is in Shengking that the Japanese are chiefly interested. There are 13 electric concerns under Japanese management, as against two or three managed by Chinese. Of the 13 concerns, some are nominally joint Sino-Japanese undertakings. The total quantity of electricity generated by these Japanese or Sino-Japanese concerns is 20,000 KW. This is almost entirely consumed by Japanese business undertakings in the provinces. The only tramway of any consequence is one of 25 miles in length, operated by the South Manchurian Railway Co. with 60 cars. The total number of lamps is 180,000, and the total capital invested 213,800,000 yen, of which the South Manchurian Railway Co. accounts for about 200,000,000 yen. The largest establishment is the No. 1 power house of the South Manchurian Railway Co., which generates (by steam power) 4,500 KW., and lights 65,000 lamps in Dairen and neighbourhood. The second largest concern is the No. 2 power house of this company at Antung, which generates 966 KW. by gas power, and lights 16,000 lamps. There is a third power house owned by the same company at Mukden, and the Manchurian Electric Light Co., with a capital of 150,000 yen, operates in Kai-yuen and that neighbourhood, but these are not large concerns. The largest Sino-Japanese concern is the Yingkow Hydro-Electric Co.; capital, 2,000,000 yen. It generates 850 KW. by steam power, which supplies 15,000 lamps. The Kwantung Government operates another power house in Port Arthur, which lights 11,000 lamps. There are few other electrical concerns in this province.

Shantung.—Developments in Shantung are backward. There are no tramways, and only four concerns under Chinese management. Foreign enterprise is limited to establishment under the management of the Japanese authorities. The total electricity generated in the province is 5,000 KW. The chief establishment is the Tsingtau power house, supplying 2,500 KW. by steam power for 30,000 lamps. There are electric light companies in Tsinan, Chifu, and Tsining, with 6,000 to 9,000 lamps each. The article concludes by stating that with the exception of the above-mentioned provinces of Shantung, Kiangsu, Canton, and Shanghai, Japanese capital is invested only in Chilili, Hupeh, and Kirin, with a total amount of only some 670,000 yen.

Thus the electrical business in China is only awaiting foreign capital for development.—*B.O.T. Journal.*

Metallic-Arc Electrode Temperatures.—The observations on metallic arcs made by Messrs. A. Hagenbach and K. Langbein (*Archives des Sciences Naturelles*, Genève, 1919, pp. 48-54) tend to support the assumption that the constancy of the temperature of the crater of carbon electrodes is explained by the assumption that the temperature observed represents the boiling point of the carbon, and is independent of the heating current. Hagenbach and Langbein experienced considerable trouble with metallic arcs, which are notoriously unsteady, especially when measuring the temperatures of the cathodes. The method used—photometer of König-Martens—is the same that O. Lummer applied in his recent researches on carbon arcs, and the softening or melting of carbons, and their carbon-crater temperature, 4,200 deg. C. absolute, agrees with Lummer and others. Anode and cathode temperatures were determined; temperatures are understood to refer to the anode unless otherwise stated. With increasing current intensity, the brightness of the light, says *Engineering*, in some cases increased visibility until a certain current intensity was reached, above which the brightness and temperature remained steady. That was so with silver, copper, iron, and nickel; a large range was found for silver; the smallest for nickel; with silver, constancy was not attained. In the case of copper a current of 2 amperes gave a temperature of 2,235 deg. C. absolute, which rose to 2,450 deg. when the current was raised to 10 amperes, and did not change any further with current intensities up to 18 amperes. The tungsten arc proved practically constant at 4,150 deg. C., or 4,250 deg. C. for all current intensities. The temperatures of the cathode were, as with carbon, always lower; thus with copper the cathode temperature did not exceed 1,450 deg., remaining about 1,000 deg. below that of the anode; with iron, the anode yielded 2,485 deg. to 2,605 deg., whilst the cathode did not heat above 2,430 deg., with nickel the anode temperature varied, with the stated variations of the current intensity, between 2,430 and 2,450 deg., whilst the cathode maximum was 2,365 deg.; tungsten gave 4,250 deg. at the anode, and 3,000 deg. at the cathode. Aluminium, zinc, and magnesium differed from the metals so far mentioned in giving the same temperatures at both the electrodes, 3,350 deg. to 3,450 deg. for aluminium, 2,350 deg. for zinc, and about 3,000 deg. for magnesium. These latter temperatures are unexpectedly high, and the suggestion is made that the temperatures observed are not those of the boiling metals, but those of the oxides, which are much less volatile than the metals, and might, hence, be considerably superheated, and have also high melting points. The suggestion finds some support in special observations made in atmospheres of nitrogen, whilst the figures so far given all refer to arcs burning in air. In nitrogen the temperatures were all much lower, by as much as 1,000 deg. in the case of aluminium, but this applies only to the three metals Al, Zn, Mg. Of these, magnesium and zinc arcs may be called easily-oxidisable. Aluminium only covers itself with a surface film of oxide at ordinary temperature; at high temperatures aluminium must be considered oxidisable. Iron is readily oxidisable as well, however, and yet the electrode temperatures of iron, nickel, and copper were the same in nitrogen as in air.

Electric Furnace Regulator.—Messrs. W. P. White and L. H. Adams, of the Geophysical Laboratory, Washington, formerly obtained a regulation within 5 deg. by allowing a thermocouple recorder to make electrical contacts which actuated a polarised relay controlling the heating current through the intermediation of a large magnet. But a much more delicate control was required, and it was found that adjustments were required almost every second. Hence an arrangement, described in the *Physical Review* of July last, was adopted, and consists in making the heating coil of an electric furnace one arm of a Wheatstone bridge, which method has succeeded in keeping the temperature of a laboratory electric furnace constant for hours within 0.1 deg. at temperatures between 500 deg. and 1,400 deg. C., practically without any attendance. The energy for regulation is taken from the heating coil itself, a platinum coil, and the energy available for regulation is hence very great; the regulator is practically a resistance thermometer with currents of 18 amps.; the average current is 14 amps. There is no lag between heater and regulator, since the two are identical, and no need for introducing further appliances into the heater cavity. The disadvantage of the arrangement is that the temperature of the furnace is influenced by the room temperature and may thus vary slightly even when the coil temperature is kept constant. The current-regulating switches are moved in accord with changes in the position of the galvanometer boom. The movement can be effected by means of a device (small motor) pressing the boom down at intervals so as to strike or to miss a contact-maker controlling a relay. As the regulation depends upon the variation of the coil resistance with temperature, the arrangement is not well adapted for nichrome coils which have a very small temperature coefficient. It is further noteworthy that the arrangement, at least in the form described, is restricted to direct-current heating.

Central-Station Heating at Detroit.—Mr. J. H. Walker at the American Society of Mechanical Engineers, spring meeting, June, 1919, discussed the general problem of the utilisation of the heat ordinarily discharged to the condensing water in a central electric generating station. The impossibility of its complete utilisation for the purpose of heating buildings and the difficulties in the way of even its partial utilisation were pointed out, with particular reference to conditions existing in Detroit, Michigan. The development of the central heating system of the Detroit Edison Co. was traced, showing how the use of exhaust steam for heating was abandoned in favour of live steam. The reasons why it is more commercially expedient under the existing local condition to supply live steam to the heating system and to generate all electric current in the condensing stations were also fully brought out. The paper also described some interesting features of the central heating system in Detroit, such as the boiler plant, distributing system, underground construction of pipes and tunnels, consumers' installations and meters. Special mention was also made of distribution losses, condensation return lines, and the method of transmitting steam through feeders at high velocities and with large pressure drops. The paper concluded with a discussion of the advantages of central heating service and of the obstacles to its wider use. It also pointed out the possibility of operating individual plant in combination with the central plant.

Southern California Water Power.—A short time ago the Southern California Edison Co. completed its new financing for the present year by the sale of $16,000,000 of bonds and debentures, which was the first financing in the West on a large scale since the war was concluded. Announcement is now made by the company concerning the starting of active work on its hydroelectric construction programme which the management has been waiting to inaugurate for some time past. Twenty million dollars will be required to carry out the plans for the construction of new hydroelectric plant during the next three years, and their completion will mean the development of 66,000 H.P. in new hydroelectric plant and an additional annual output of 310,000,000 KW.-hour. The new development on Kern River, 150 miles (240 km.) from Los Angeles, deriving its water supply from the watersheds in Kern and Tulare Counties, has a total installed capacity of 40,000 H.P. This plant will be known as Kern river No. 3, the company already having two other plants on the same stream. The new plant will consist of two units of 20,000 H.P. each. A feature of the construction will be a tunnel 12 miles (19 km.) long, 8 ft. by 10 ft. (2.4 m. by 3 m.) in dimension. Two pipe lines, each carrying 15,000 miners' inches of water, will require 1,500 tons of steel pipe. The water drop will be 800 ft. (240 m.). It is on this project that 2,000 men will work for eighteen months, and it is expected that the plant will be put into commission about September, 1920.

Big Creek plant No. 2, in Fresno County, 240 miles (384 km.) from Los Angeles, is also the scene of active work at the present time. The Big Creek system now consists of two plants with a total capacity of 88,000 H.P., each plant containing two 2,200-H.P. generators. It is proposed to install immediately in Big Creek plant No. 2 one additional generator of the same size, which will necessitate the construction of an additional pipe line requiring 1,100 tons of steel. Later a similar unit will be required at No. 1 power house under practically the same conditions. It is expected that the additional installation at Big Creek plant No. 2 will be completed and put into commission about the month of April, 1920.

The development of Big Creek plant No. 3, which will be next in order, will use all the water supplied by Huntington Lake after it passes through the two existing power houses. The combined head of power houses No. 1 and No. 2 is 4,000 ft. (1,200 m.). Big Creek plant No. 3 will make available 1,350 ft. (405 m.) additional, and a fourth plant, which will be a later installation, will make available another 600 ft. (180 m.), resulting in the water being eventually utilised under a total drop of 5,950 ft. (1,785 m.). The first development at Big Creek No. 3 of 68,000 H.P. will ultimately be increased to over 200,000 H.P. The Big Creek plant No. 3 will, however, not be started until after the completion of the work laid out and now under way for the three-year period.

The three-year programme also includes the diversion of other waters in the Big Creek watershed in Huntington Lake, increasing the amount of water available for storage purposes. In later years additional reservoirs and water diversions are to be provided which will very largely increase the amount of water for the Big Creek power houses and justify the construction of additional plant. The immediate construction plans are really a part of a comprehensive programme which will ultimately result in the development by the company of 750,000 H.P. in hydroelectric plants, requiring an expenditure for plant, lines and sub-stations of $125,000,000. The service of the company now extends to ten counties in Southern California and the San Joaquin Valley, over 55,000 sq. miles (14,245,000 hectares), serving upward of 200,000 consumers in 233 cities, towns, and intervening rural territory.

Construction is beginning on a new hydroelectric plant in the Great Western chain of generating stations in California. The company recently completed the financing by the sale of $6,000,000 in bonds and $1,500,000 in preferred stock. It is estimated that the plant will be completed in about two years' time, the plan being to use the power in the general distribution system around the bay region. The plant is to be built in the canyon of the North Fork of the Feather river about 9 miles (14.4 km.) above Belden on the Western Pacific railroad. By means of tunnels both the Lake Almanor watershed and that of Butte Valley will be made available for the new plant. A tunnel about 2 miles (3 km.) long will be driven from Lake Almanor into Butte Valley, whence water will flow into Butte Creek channel to a point near the junction of the north fork of the Feather river, where a dam is to create a small reservoir. A second tunnel, about 2 miles long, will be driven from this reservoir to a point directly above the power house, whence a 1,100-ft. (335-m.) head will be made available through steel penstocks in rock tunnels. Water discharged from the Caribou plant into the north fork of the Feather river will be used again at the Las Plumas plant, which is about 40 miles (64 km.) further down the river. For the present the power house is to contain two 20,000-KW. units with transformer equipment for stepping up to 160,000 volts. The probable ultimate capacity, it is stated, will be 120,000 KW., with a possible increase to 136,000 KW. A 150,000-volt steel tower line is to be built from Caribou to a point on the north shore of Carquinez Straits. For a considerable distance this line will parallel the existing 100,000-volt line from Las Plumas to Oakland. Because of the 300,000-acre-feet storage capacity at Big Meadows and Lake Almanor, together with the high natural run-off from the Butte Valley watershed, it is expected that the new plant can be operated at a high percentage of installed capacity. This plant is part of a comprehensive scheme whereby the Great Western Power Co. expects to develop a total of 635,000 H.P. in plant above Oroville in the Feather river basin.—*Electrical World*.

Electrical Control by Vibration.—The control of electrical machinery by the sound of a whistle at any distance up to a mile was recently demonstrated to a *Sunday Express* representative. By the blowing of a whistle a small motor-car was started, directed to the right or left, and stopped by repeated sounds. The model was fitted with the essential batteries, and no wires or wireless apparatus are claimed to have been used. Vibration alone is responsible, and the same results are claimed to have been accomplished by means of inaudible vibrations. The inventor, Captain A. J. Roberts, an Australian flight captain, is said to have produced other inventions connected with wireless in the air and the controlling of torpedoes by the same means. Some of his inventions were described in our pages a few years ago.

The James Watt Centenary.—Messrs. Vickers, W. & T. Avery, and the Birmingham Small Arms Co. have each offered £1,000, towards the sum of £200,000 required to establish a Research Institute in connection with the University of Birmingham, as a James Watt memorial.

OUR PERSONAL COLUMN.

The Editors invite electrical engineers, whether connected with the technical or the commercial side of the profession and industry, also electric tramway and railway officials, to keep readers of the ELECTRICAL REVIEW *posted as to their movements.*

Central Station and Tramway Officials.—Mr. T. A. TAYLOR, A.M.I.E.E., assistant engineer, Burma Electric Tramway and Lighting Co., Ltd., is expected to arrive in England about October 1st on six months' privilege leave.

Mr. ARTHUR ELLIS, the Cardiff Corporation electrical engineer and tramways manager, is about to retire after about 20 years' service under the Corporation, in order to set up in private practice.

Consequent upon Mr. GADSBY, the chief assistant engineer at Hove, having resigned his position, it became necessary to reorganise the staff, and Mr. Liggins has been promoted to the position at £325 per annum.

Mr. PENFOLD, an old member of the staff, has been appointed shift engineer at the Dover Corporation Electricity Works.

Sunderland Tramways Committee has appointed Mr. H. HARRISON, of Ashton-under-Lyne, assistant traffic superintendent. There were 39 applicants for the post.

The residence of Mr. THOMAS ROLES, electrical engineer to the Bradford Corporation, has been broken into during his absence on holiday and several articles are missed. Mr. Roles has our sympathy.

The Chesterfield Corporation has appointed Mr. H. CAMPION, manager of the Dewsbury Municipal Electricity and Tramway Departments, to a similar position in connection with its own undertakings, at a commencing salary of £600 per annum, in succession to Mr. R. L. Acland, who has left to take up a post with a London transport company. Mr. W. A. Toppin, who since Mr. Acland's resignation has been acting manager of both the electricity and tramway undertakings, has been appointed assistant general manager, at £300 per annum, plus £120 per annum war bonus.

Mr. E. T. PRICE, chief electrical engineering assistant of the Johannesburg Municipal Gas and Electric Supply Department, is leaving the Council's service in order to take up a commercial position.

General.—The marriage was solemnised at St. Matthew's Church, Burnley, on September 12th, of Capt. J. B. HARTLEY, M.C., electrical engineer with the British Westinghouse Co., Manchester, and Miss A. Stuttard, daughter of a leading cotton manufacturer. The presents included stainless cutlery from the bridegroom's colleagues at the Westinghouse Works.

The wedding took place at Halifax, on September 11th, between Mr. J. H. GATH, of the Gath Electrical Engineering Co., Halifax, and Miss Lucy Tasker, of Halifax. The employés of the firm presented the bridegroom with a clock suitably inscribed.

The *Times* states that Mr. A. J. BALFOUR, O.M., is to be nominated for election as Chancellor of Cambridge University, in succession to his brother-in-law, the late Lord Rayleigh.

Mr. W. J. HAMILTON PORTER, A.M.I.E.E., for the past seven years district manager in South Wales and the West of England for the British Westinghouse Electrical and Manufacturing Co., Ltd., was entertained to dinner on Friday last by a circle of friends on his relinquishing his connection with the firm in order to take up business in the Cardiff district as a mechanical and electrical engineer. Mr. P. J. Plevin, M.I.Mech.E., Mr. Porter's successor as district manager for the company, was in the chair, and presented Mr. Porter with a chiming clock, which had been subscribed for by a large number of his friends. The opportunity was taken also to present to Mr. H. Townsend,

who is leaving the staff of the British Westinghouse Co. in Cardiff, with a gold-mounted cigarette case. Mr. Porter has been responsible for the supply and erection of many of the largest electrical equipments in the district. It is his intention to specialise in all kinds of electrical and mechanical plant for collieries, steel works, and other industrial concerns in South Wales and the West of England.

Messrs. Siemens Brothers & Co., Ltd., inform us that five members of their staff, officers in the company's cable ship *Faraday*, have received letters of commendation from the Admiralty for their services during the war, and a letter has been sent to each officer by the Lords Commissioners of the Admiralty. The letter states that the work performed by the cable ships during the war, carried out under extremely arduous and hazardous conditions, has been of the greatest assistance to the British and Allied cause, the maintenance of the communications of the Empire being of the highest importance to naval and military operations.

Mr. J. A. Crabtree, late works manager for Messrs. J. H. Tucker & Co., Ltd., has commenced business under the name of J. A. Crabtree & Co., Ltd., 21, Upper Rushall Street, Walsall, manufacturers of electrical tumbler switches. Mr. A. E. Mills, for eleven years Midland and Liverpool representative for J. H. Tucker & Co., has resigned, and has joined Messrs. J. A. Crabtree, Ltd., as sales director.

NEW COMPANIES REGISTERED.

British Australian Engineering Co., Ltd. (158,607).—Private company. Registered September 8th. Capital, £25,000 in £1 shares. To carry on in Australia or elsewhere the business of manufacturers, merchants, contractors, mechanical, mining and electrical engineers, &c., and to enter into agreements (1) with H. C. Siddeley and (2) with R. W. Wild. The subscribers (each with one share) are: J. A. Hirst, Donacloney, Duganwy, N. Wales, electrical engineer; A. Ewing, Fallowfield, Cranes Park Avenue, Surbiton, mechanical engineer. The first directors are: R. S. Brailsford, A. Ewing, J. A. Hirst, H. J. Marshall and W. Newall. Qualification, £250. Registered office: Australia House, Strand, W.C.2.

John Coates (Electro-Platers), Ltd. (158,645).—Private company. Registered September 9th. Capital, £1,500 in £1 shares. To take over certain plant, machinery and assets, suitable for the business of galvanising, electro-galvanising, and electro-plating iron and steel, from N. Crowther, of Gratton Road, Bradford. The first directors are: N. Crowther, 102, Bradford Road, Idle, flexible tube manufacturer; H. Croft, 89, Waverley Road, Bradford, secretary; J. Coates, 48, Fieldhead Road, Listerhills, Bradford, electro-plater. Solicitors: Geo. Furniss, Roberts & Co., Brighouse. Registered office: 41, Grattan Road, Bradford.

Semco, Ltd. (158,689).—Private company. Registered September 10th. Capital, £7,000 in £1 shares (3,000 10 per cent. preference). To carry on the business of electricians, mechanical engineers, suppliers of electricity, &c., and to adopt an agreement with A. E. Grubb, S. E. Grubb, T. E. Nankivell and E. F. Burrill. The subscribers (each with one ordinary share) are: T. E. Nankivell, 39, Junction Road, Romford, Essex, electrical engineer; E. F. Burrill, 83, Downs Road, Clapton, N., electrical engineer. Directors: A. E. Grubb, T. E. Nankivell, E. F. Burrill and S. E. Grubb. Qualification, £250. Registered office: 19-20, High Street, Shoreditch, E.1.

Electrical Engineering (West Bromwich), Ltd. (158,578).—Private company. Registered September 6th. Capital, £5,000 in £1 shares. To carry on the business of electrical, mechanical and consulting engineers, electric light and power installers, &c. The subscribers (each with one share) are: J. D. Carlmark, 402, High Street, West Bromwich, electrical engineer; T. A. Nightingale, Billhay Street, West Bromwich, merchant; C. V. James, 32, Thynne Street, West Bromwich, manufacturer. The subscribers are to appoint the first directors. Qualification, £100. Solicitor: A. A. Millicents, West Bromwich.

Eastern Engineering and Supply Co., Ltd. (158,667).—Private company. Registered September 10th. Capital, £5,000 in £1 shares. To carry on the business of electrical, mechanical, sanitary, gas, hydraulic, water and general engineers, manufacturers of machinery, electrical apparatus, theatrical and general stage effects, &c. The subscribers (each with one share) are: Ethel Berry, 9, Hartfield Crescent, Wimbledon, S.W.19, clerk; Winifred P. Martin, 100, Sewardstone Road, Victoria Park, N.E., clerk. The subscribers are to appoint the first directors. Qualification, 100 shares. Secretary: F. A. Walker. Registered office: 351, High Street, Stratford, E.15.

Phœnix Electrical Co., Ltd. (10,621).—Private company. Registered in Edinburgh, September 10th. Capital, £20,000 in £1 shares. To carry on the business of engineers, electricians and dealers carried on as the Phœnix Electrical Company, or by T. H. Large, in his own name. The subscribers (each with one share) are: J. McCallum, 95, Bath Street, Glasgow, solicitor; S. M. Galloway, 45, West Nile Street, Glasgow, C.A. The first directors are: J. Boag and T. H. Large. Registered office: 32, Broomielaw, Glasgow.

Wainwright Manufacturing Co., Ltd. (158,566).—Private company. Registered September 5th. Capital, £2,000 in £1 shares. To carry on the business of manufacturers of, agents for and dealers in kinematograph machines, electrical and engineering appliances, &c. The subscribers (each with one share) are: E. Wainwright, 44, Montalt Road, Woodford Green, Essex, merchant; S. W. J. Vaisey, 15, Rowan Road, Hammersmith, W., merchant. The first directors are: E. Wainwright (managing director and S. W. J. Vaisey (both permanent). Qualification, £10. Registered office: 159, Victoria Street, S.W.1.

McKeown & Martin, Ltd. (4,778).—Private company. Registered in Dublin, September 2nd. Capital, £5,000 in £1 shares. To carry on the business of electrical engineers, &c. The subscribers (each with one share) are: J. J. McKeown, 84, University Road, Belfast, electrical engineer; C. R. Martin, Annamoe, Chichester Park, Belfast, electrical engineer. The first directors are: J. J. McKeown and C. R. Martin. Registered office: 3, Bridge Street, Belfast.

R. M. Radio, Ltd. (158,602).—Private company. Registered September 6th. Capital, £10,000 in £1 shares. To buy, sell, let or otherwise deal in radio apparatus of any kind, to establish and maintain a registry of radio operators and a school of instruction in radio apparatus and the proper working and control thereof, to transmit and receive radio messages, and to carry on the business of engineers and manufacturers of radio apparatus of all kinds, &c. The subscribers (each with one share) are: H. R. Rivers-Moore, 28, Park Hill Road, Croydon, engineer; Captain H. St. J. de A. Donisthorpe, Cathcart House, Cathcart Road, S.W.10. The subscribers are to appoint the first directors. Secretary: G. Horswell. Registered office: 5, Chancery Lane, W.C.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Lobito Benguella and Catumbella Electric Light and Power Co., Ltd.—C. O. Webb, of 1, Queen Victoria Street, E.C., as receiver on July 11th, 1919.

Rushmores, Ltd.—Mortgage on land and premises at Fulham and Balham, registered August 1st, 1919, by way of transfer and further charge securing £24,450 9s. 4d. Holders: British Safety Blades, Ltd.

Litholite Insulators, Ltd.—Satisfaction in full on July 30th, 1919, of charge for £3,000 registered November 19th, 1907.

CITY NOTES.

Kalgoorlie Electric Tramways, Ltd.

Mr. A. H. P. Stoneham, presiding at the annual meeting, said that on a reference to the balance sheet it would be seen that the gross receipts for the year amounted to £33,900, as against £32,979 in 1917, and that the net profits earned before charging depreciation were £1,601, as against £3,928. The increase of 1d. on workmen's tickets and the extra 1d. on transfers had resulted in an addition to the receipts of £1,097. The increase in the wages bill consequent on the last award and the continued high prices necessitated the consideration of the question of cutting down the car mileage, and after much discussion and lengthy negotiations a new time table had been agreed. The working expenses for the year showed a decrease of £1,056, chiefly due to a reduction in power consumption. The position in Australia had not improved during the period covered by the accounts. There had been many strikes recently, including one on the Trans-continental Railway, the seamen's strike, and the lumpers' strike, which practically isolated Western Australia. There was, however, a gleam of hope in the position. A cablegram had just appeared in the Press from Perth regarding gold discoveries at Hampton Plains. Workable value depended, of course, on cost, which was chiefly a matter of labour, and labour had practically killed mining and enterprise of all descriptions in Kalgoorlie. Many mines which would have paid their way had been unable to give the huge wages demanded. On the other hand, dozens of mines were equipped with machinery they could not use, and which could, no doubt, be transferred to the new district.

German Companies.

The directors of the *Wotan Werke A.G.*, of Leipsig, recommend a dividend and bonus at the rate of 30 per cent. for 1918-19, as against 40 per cent. in the preceding year.

The Internationale Stickstoff A.G., of Wiesbaden, after apportioning £4,000 to depreciation in 1918, as against £3,000 in 1917, reports a fresh loss of £7,000, thus increasing the debit balance to £56,000.

The A.G. fur Elektrizitats Industrie, of Hamburg, records net profits of £4,400 for 1918-19, as contrasted with £5,200 in the preceding year, and a dividend of 7 per cent., as in 1917-18, is in contemplation.

The Continentale Isola Werke A.G., of Duren-Birkesdorf, after placing £8,000 to depreciation in 1918-19, as compared with £16,000 in the previous year, reports net profits of £16,000, as against £33,000. The dividend on the ordinary shares is at the rate of 5 per cent., and contrasts with 10 per cent. in 1917-18.

The A.G. fur Elektrische Unternehmungen, of Munich, after placing £3,000 to depreciation in 1918-19, as compared with £2,500 in the previous year, reports net profits of £4,800, as against £4,100. It is proposed to pay arrears in the dividend on the preference shares for 1917-18.

The A.G. Korting Elektrizitats Werke, of Berlin, reporting on the year 1918-19, states that the maintenance of working at the supply works was again attended with the greatest difficulties. It is intended to pay a dividend of 6 per cent. out of net profits of £10,000, as compared with 4 per cent. and £10,000 respectively in 1917-18.

The directors of *The Elektra A.G.*, of Dresden, which is an investment company for supply works and tramways, reports net profits of £1,100 for 1918-19, as against a loss of £2,200 in the previous year. It is again impossible to make any distribution, and the small surplus and £8,000 drawn from the reserve fund have been applied to the writing down of securities.

Direct Spanish Telegraph Co., Ltd.—Interim dividend of 4 per cent. per annum, free of income tax, on ordinary shares for the half-year.

Western Telegraph Co., Ltd.—Dividend 3s. per share, and a bonus of 4d. per share, both free of income tax, making a total of 8 per cent. for the year.

Globe Telegraph & Trust Co., Ltd.—Quarterly dividend of 3s. on the preference and 2s. on the ordinary shares, both free of tax.

British Insulated & Helsby Cables, Ltd.—Interim dividend of 9d. per share, less tax.

Davis & Timmins, Ltd.—Interim dividend of 6 per cent. per annum, free of tax, on ordinary shares for the half-year.

British Aluminium Co., Ltd.—Dividend at the rate of 6 per cent. per annum on the preference shares, and at the rate of 8 per cent. per annum on the ordinary shares, both for the six months to June 30th.

General Electric Co. (U.S.A.).—Dividend 2 per cent., less tax, on capital stock for quarter.

Browett, Lindley & Co., Ltd.—Interim dividend of 4 per cent. on the ordinary shares for the half-year to June 30th.

Nairobi Electric Power & Lighting Co., Ltd.—Interim dividend of 4 per cent., less income tax.

Prospectus.—*The Rapid Submersible Ship Cleaner Co., Ltd.*—The list was to close on Wednesday in an issue of 145,000 shares of £1 each. The cleaner is worked by a submersible electric motor.

Bruce Peebles & Co., Ltd.—Dividend at the rate of 7½ per cent. per annum, less tax, on the cumulative participating preference shares, for the June half-year.

STOCKS AND SHARES.

TUESDAY EVENING.

DEALINGS in the new Victory and Funding Loans, which started on Monday, have taken up a good deal of investment money, and for the time being the newcomers are naturally the most conspicuous stocks in their particular market. Allowing for the accrued interest, &c., the various shapes stand at a small discount, from which it is obvious that the substantial buying orders which were placed in advance did not suffice to stem the stream of selling from those who have already got tired of holding the Loans. It is plain, however, that the influence of the latter upon investment stocks as a whole will be quite light, for elsewhere in the Stock Exchange the effect of commencement of dealings in the securities has been practically nil.

Notwithstanding the elasticity imparted to Stock Exchange markets by the withdrawal of various Treasury restrictions which hampered the free course of investment during the war, investors still find difficulty—so at least stockbrokers' correspondence shows—of obtaining suitable channels for their money. The popular demand is for capital appreciation rather than good dividends, the reason, of course, being that on profits made in Stock Exchange markets there is no income tax to pay, whereas on dividends the story is just the reverse. In other words, speculation is fostered by the high income tax and the exalted cost of living. Nevertheless, the investor knows well enough that, after all, security is the thing which counts, and the wise man periodically puts by a certain sum that shall bring him in a steady income. In view of the many inquiries that are current for investment stocks, we append a list of various preference issues connected with electrical undertakings that deserve attention of the man with money to invest. Our weekly list affords good examples of sound stocks, but a few others may be added to suit the varying requirements of those who want a safe, or a not-quite-so-safe, stock to hold for investment purposes:

Preference Shares.	Price.	Yield. £ s. d.	Interest payable.
Adelaide Elec. Supply 5% (tax free) "A" Cum.	1	5 net.	Mar. & Sept. (Full div. in Mar., 1920.)
British Electric Traction 6% Cum. part	76	7 18 0	Jan. & July.
Crompton & Co. 7% Non-Cum.	24/-	8 6 6 (on last year's div.)	Jan. & July.
Newcastle-on-Tyne Electric 5% Non-Cum. part.	18/-	5 11 0	Mar. & Sept.
Para Electric Railways 6% Cum. ..	4½xd.	7 7 6	Mar. & Sept.
Potteries Electric Tract. 5% Cum. ..	12/9	7 16 6	Feb. & Aug.
Tramways (M.E.T.) Omnibus 7% Cum.	20/6	6 16 6	June & Dec.
Yorkshire (W. Riding) Trams 6% Cum.	4½	7 5 6	Jan. & July.

We add half-a-dozen debenture stocks to give an idea of what is available in this department:—

Debenture.	Price.	Yield. £ s. d.	Interest payable.
Edmundson's Elec. 1st Mort. (4½%) ..	71	6 6 6	Jan. & July.
Electric Construction 4% perp. 1st Mort.	68	5 17 6	Jan. & July.
English Electric 5½% Sinking Fund 1st Mort.*	91⅞	6 0 0	Jan. & July.*
Sao Paulo Tram, Light and Power 5% perp. Cons.	70xd	6 6 6	Mar. & Sept.
Tees Power Station 6% 1st Mort. ..	102½	5 17 0	Apl. & Oct.
Urban Electric Supply 4½% 1st Mort. ..	71	6 6 6	Apl. & Oct.

* Full interest in January.

These yields do not allow for redemption or accrued interest.

The market for Home Railway stocks is dull and heavy. Those who bought Home Railways a fortnight ago are already beginning to regret their haste, and the reason for the depression is ascribed, as usual to labour difficulties. Metropolitan has shed 1½, Districts the same, Underground Incomes are a point lower. The £10 shares lost half-a-crown.

Activity in Marconis is once more noticeable, and the parent shares enjoyed a recovery, on the cessation of the foreign selling. Simultaneously, American Marconis, after being weak, took a sharp turn for the better, and rose to 33/6 on the reiteration of rumours that the company will be taken over by the General Electric of New York. Canadian and Marconi Marines are attracting no particular attention. The cable market is firm, and a number of dividend announcements have served to keep alive investment attention in this department. The Direct Spanish announces its usual interim dividend of 4 per cent., free of income tax, payable October 1st. The Western Telegraph has declared a dividend of 3s. and bonus of 4s., both free of tax, making 8 per cent. for the year ended June 30th last, payable September 29th, this also being the rate to which the dividend was raised three years ago. It is taken for granted that the Eastern Extension, Eastern Telegraph and Globe companies will repeat their regular 8 per cent. Indo-Europeans are flat on the fixing of the rupee at 2s. The price is £4 down. The firmness of the American group continues. In manufacturing shares there is no particular change. The British Insulated company has announced an interim dividend of ninepence on the ordinary shares, the same as a year ago, and the price is unchanged.

Siemens are a good market at 27s. 9d., showing a florin rise on the week. No surprise will be felt if the price goes to at least 30s., which the shares appear to be worth. British Aluminium ordinary have hardened to 33s. 9d. Babcock & Wilcox recovered to 3⅞ after having been easier. There is a good deal of quiet demand for commercial shares.

Electricity supply issues keep dull. Westminsters have dropped to their par level of 5, and pay 8 per cent. on the money on the basis of the last dividend. St. James' and Pall Mall are ¼ lower, and can be bought to yield £8 3s. 4d. per cent. South Londons have eased off, but Metropolitans rallied to 3. The quartette of City and County shares is ex dividend; the returns look attractive in the case of these shares also.

Brazilian Tractions continue to feel the favourable effect from the recent report. British Columbia Electric stocks are rather better. Mexicans, however, remain weak; further falls have occurred in some of the stocks. Argentines discover no particular change. The rubber share-list is flabby, with prices on the down grade despite the firmness of the raw material. Engineering and Armament shares, with those of the base-metal group, are inactive.

SHARE LIST OF ELECTRICAL COMPANIES.

	Dividend 1917.	Dividend 1918.	Price Sep. 16, 1919.	Rise or fall.	Yield p.c.
HOME ELECTRICITY COMPANIES					
Brompton Ordinary	10	8	6	—	£6 13 4
Charing Cross Ordinary	4	4	2⅝	—	7 5 6
do. do. do. 4½ Pref...	4½	4½	3	—	7 10 0
Chelsea	5	5	3	—	5 0 0
City of London	8	8	1⅛xd	—	7 0 8
do. do. 6 per cent. Pref. ..	6	6	9½xd	—	6 9 9
County of London	7	7	9½xd	—	7 11 5
do. do. 5 per cent. Pref.	5	5	9½xd	—	6 9 9
Kensington Ordinary	7	6	5	—	6 0 0
London Electric	Nil	Nil	1½	—	Nil
do. do. 3 per cent. Pref...	3	3	2⅝	—	8 5 6
Metropolitan	4	5	3	+ ⅛	8 6 8
do. 4½ per cent. Pref. ..	4½	4½	3 1/16	—	7 1 2
St. James' and Pall Mall	9	10	6¼	— ¼	8 8 4
South London	5	5	2 1/16	— 1/16	7 8 6
South Metropolitan Pref.	7	7	1	—	7 0 0
Westminster Ordinary	9	8	5	— ½	8 0 0
TELEGRAPHS AND TELEPHONES.					
Anglo-Am. Tel. Pref.	6	6	96	—	6 5 0
do. Def.	1½	22/6	22½	—	7 9 0
Chile Telephone	8	8	6⅔	—	5 18 6
Cuba Sub. Ord.	7	7	10½	—	*6 13 4
Eastern Extension	8	8	15⅔	—	*5 5 0
Eastern Tel. Ord.	8	8	150½	—	*5 6 4
Globe Tel. and T. Ord.	7	8	15⅔	—	*5 5 0
do. do. Pref.	6	6	10⅝	—	5 18 6
Great Northern Tel.	22	22	23⅝	—	7 14 5
Indo-European	13	13	4½	—4	6 16 10
Marconi	20	25	5⅝	+ ⅛	4 11 0
Oriental Telephone Ord.	15	10	2¼	—	4 9 0
United R. Plate Tel.	8	8	7⅝	—	*5 1 7
West India and Panama	1/8	1/8	1/16	—	*4 15 8
Western Telegraph	8	8	16½	—	*4 18 9
HOME RAILS.					
Central London Ord. Assented ..	4	4	60½	—	6 13 1
Metropolitan	1	1½	25	—1½	5 0 0
do. District	Nil	Nil	21½	—1½	Nil
Underground Electric Ordinary ..	Nil	Nil	8½	— ⅛	Nil
do. do. "A" ..	Nil	Nil	8/8	—	Nil
do. do. Income ..	4	5	93½xd	—1	*5 7 0
FOREIGN TRAMS, &c.					
Adelaide Sup. 6 per cent. Pref. ..	6	6	4½	—	6 13 4
Anglo-Arg. Trams. First Pref. ..	5½	Nil	3	—	—
do. do. 2nd Pref. ..	—	—	2½	—	—
do. do. 5 Deb... ..	5	5	68½	—1½	7 17 6
Brazil Tractions	—	—	60⅜	+ ⅛	—
Bombay Electric Pref.	6	6	12½	—	4 18 0
British Columbia Elec. Rly. Pfce.	5	5	55⅛	—	9 1 10
do. do. Preferred	Nil	2½	4⅝	—	5 7 6
do. do. Deferred	Nil	Nil	39⅛	+ ⅛	Nil
do. do. Deb. ..	4½	4½	64½xd	+ ⅛	7 16 0
Mexico Trams 5 per cent. Bonds..	Nil	Nil	55	—	Nil
do. 6 per cent. Bonds..	Nil	Nil	45⅛	—	Nil
Mexican Light Common	Nil	Nil	32⅛	—⅛	Nil
do. Pref.	Nil	Nil	48½	—	Nil
do. 1st Bonds.. ..	Nil	Nil	60½	—	—
MANUFACTURING COMPANIES.					
Babcock & Wilcox	15	15	38	—	*4 2 9
British Aluminium Ord.	10	10	1⅛	+ 1/16	5 18 4
British Insulated Ord.	25	12½	2⅛	—	6 1 0
British Westinghouse Pref. ..	7½	8	3 1/16	—	4 15 8
Callenders	25	25	9	—	6 19 0
do. 6½ Pref.	5	6½	5½	—	6 8 10
Castner-Kellner	25	20	9⅛	—	8 0 0
Crompton Ord.	7	10	31/6	—	9 6 0
Edison-Swan, "A"	—	—	1½	—	6 0 0
do. do. 5 per cent. Deb. ..	4	5	81½	—	6 2 9
Electric Construction	10	10	1½	—	8 18 0
Gen. Elec. Pref.	5	6½	1	—	6 10 0
do. Ord.	10	10	2	—	*5 0 0
Henley	25	25	3⅛	—	8 8 0
do. 4½ Pref..	4½	4½	3⅜	—	6 4 2
India-Rubber	10	10	17	—	*5 17 8
Siemens Ord...	—	10	27/9	+2/-	*7 5 0
Telegraph Con.	20	20	26	—	*4 17 0

*Dividends paid free of Income Tax.

THE BRITISH ASSOCIATION.—II.

The Bournemouth meeting of the B.A. came to an end on Saturday morning last. It was in every respect successful. The attendance was as large as had been anticipated, but, of course, not so large as on many occasions when the meetings were held at more central situations. The number of members and associates was 1,481.

The president, Sir Chas. Parsons, struck the engineering note in his address, abstracted in our last issue, and in the Engineering Section interest was well maintained throughout the whole proceedings. Even on Saturday morning, when other Sections had put up the shutters, "G" was crowded to the doors, busily engaging itself with submarine mining matters, the paravane, and other subjects, and planning to visit the Winton Aerodrome in the afternoon.

The meeting of the Association next year will be held at Cardiff, with Dr. Wm. A. Herdman, F.R.S., Professor of Natural History in the University of Liverpool, and General Secretary of the Association from 1903 to 1919, as president. Edinburgh's invitation for 1921 has been accepted.

We give below a list of electrical, engineering, and industrial matters selected from the daily programmes :—

Section A.—Mathematical and Physical Science.

Report of Committee on Radio-telegraphic Investigations, submitted by Dr. W. H. Eccles (Secretary).
Report of Committee on Gravity at Sea.
Discussion on Thermionic Tubes (Prof. W. H. Eccles, Prof. C. L. Fortescue, Mr. B. S. Gossling, Major R. Whiddington).
"Self-oscillation in Valves," by Major R. Whiddington.
"Diffraction of Electric Waves," by Prof. G. N. Watson, F.R.S.
"On a Possible Theory of Vision," by Sir Oliver Lodge, F.R.S.
"The Ionisation of Argon and Helium by Electron Collisions," by Prof. F. Horton and Miss A. C. Davies.
"The Production of Luminosity in Helium by Electron Collisions," by Prof. F. Horton and Miss D. Bailey.
Discussion on the Principle of Relativity (Prof. A. S. Eddington, F.R.S., Dr. L. Silberstein).
"Viscosity of Liquids at High Pressure," by Dr. T. E. Stanton, F.R.S.
"Wireless Telegraphy during the first three years of the War," by Major T. Vincent Smith.
"On the Limitations of Relativity," by Mr. W. J. Johnston and Sir Joseph Larmor, F.R.S.
"How the Sun may have become a Magnet," by Sir J. Larmor, F.R.S.
Report on Wave Motion (Sir George Greenhill, F.R.S.).

Section B.—Chemistry.

"Chemistry and the War," by Sir William Pope.
"Some Geo-chemical Problems dealt with during the War," by Prof. Boswell.
"Glass Manufacture at the end of the War," by Dr. W. M. Travers.
"Metallurgy during the War," by Prof. C. H. Desch.
Discussion on Problems of Coal. Report of Fuel Economy Committee.
"The Molecular Phase Hypothesis: A Theory of Chemical Reactivity," by Prof. E. C. C. Baly.

Section E.—Geography.

"Some New Experiments in Atmospheric Electricity and Possible Connection with Terrestrial Magnetism," by E. A. Reeves.

Section F.—Economic Science and Statistics.

"National Alliance of Employers and Employed," by the Rt. Hon. F. Huth Jackson.
"Industrial Councils and their Possibilities," by J. B. Johnston.
"Transport Policy," by W. M. Acworth.
Joint meeting with the Educational Section. Opener, Sir Herbert Morgan on "Business in Relation to Education."
"The Task of the Universities," by C. R. Fay.
Joint meeting with Physiological Section and Psychological Sub-section on "Influence of the Six-hour Day on Industrial Efficiency and Fatigue" (Dr. H. M. Vernon), "American Experience," by Mr. P. Sargant Florence. "The Energy Requirements of Heavy Labourers," by Prof. A. W. Waller, F.R.S.
Report of Committee on "Replacement of Men by Women in Industry" (Prof. A. W. Kirkaldy and Miss L. Grier).
"Inter-imperial Communication through Cable, Wireless and Air," by Sir Chas. Bright.
"The Special Taxation of Business Profits in Relation to the Present Position of National Finance," by Dr. J. C. Stamp, C.B.E.
Report of Sub-Committee on Income Tax.

Section G.—Engineering.

Report of Committee on "Complex Stress."
Visit to Bournemouth Corporation Tramways Generating Station. Electric welding, oxy-acetylene welding and cutting, sorbitic treatment of rails *in situ*. Visits to Gas and Water Works and to Royal Naval Cordite Factory at Holton Heath.
"Development of Geared Turbines for the Propulsion of Ships," by R. J. Walker.
Papers on Tanks, Military Bridge Construction, Airships, Aviation matters, the Paravane, &c.
"Directional Wireless with Special Application to Aircraft," by Capt. J. Robinson.
"The Three-electrode Thermionic Valve as an A.C. Generator," by Prof. C. L. Fortescue.
"A new arrangement for Generating Oscillations by means of Thermionic Valves," by Prof. W. H. Eccles.
"A Trigger Relay Operated by Thermionic Valves," by Prof. W. H. Eccles.
"Gaseous Ignition by Hot Wires," by Prof. W. M. Thornton.
"The Thermal Conductivity of Heat Insulators," by Prof. W. M. Thornton.
"Submarine Mining," by Commander A. L. Gwynne.

Psychology Sub-section of the Physiological Section.

"Theoretical Basis of Industrial Psychology," by T. H. Pear.
"Industrial Overstrain and Unrest," by Dr. C. S. Myers.

Section L.—Educational Science.

Discussion upon the Method and Substance of Science Teaching.
Discussion upon Continuation Schools, opened by Sir R. Blair.
Discussion upon Training in Citizenship, opened by Bishop Welldon.
Discussion upon Fundamental Principles in Education.

Section M.—Agriculture.

"Electrical Treatment of Seeds," announced as by Dr. C. Mercier; the author having died the week before the meeting, Mr. Blackburn read a paper of his own on the same subject.

It was announced on the notice board in the Reception Room that members of Section B. Chemistry, could inspect an instrument illustrating "Sphere-tricity"; also that Mr. G. Mahomed would exhibit an apparatus for recording atmospheric electricity at the Hut, Middle Chine, Westcliff. Mr. G. Phillip Griffiths exhibited a British-made X-ray apparatus for operating from lighting circuits in Section A.

The Electro-Chemical Treatment of Seed Grain.

By Dr. A. E. Blackburn. (*Abstract.*)

Section M.—Agriculture.

All living matter, human, animal and plant life, is made up of solutions separated by walls and membranes. Those walls are permeable in different degrees. Continual changes are taking place in these solutions. To understand these changes is to understand life. It is the science of life. The rain keeps the soil humid, the sun and wind concentrate the juices of the sap. The force which determines the movements of fluids in plants is called the osmotic pressure. Now solutions which conduct electricity, as a solution of salt, have a greater osmotic pressure than we should expect from their constitution, whilst substances, such as sugar and alcohol, which do not conduct electricity, have no greater osmotic pressure than we should expect. In all probability there is a breaking up in the molecule of the salt, and the fragments are called ions, which are the carriers of the electric charges, and represent life.

I do not intend to speak of the application of electricity to seeds by overhead wires; the electro-chemical treatment of seeds is quite distinctive. Various electrolytes, that is, various solutions, are used—the seed is steeped in the solution, and a current of L.T. electricity is passed for varying times according to the nature of the grain. The dried grain, in whose latent life the currents of absorption and elimination have ceased, are ionised; they are given, as it were, added life and made more vigorous.

The first electrolytes used were the chemical manures. Wheat was steeped in a solution of nitrate of soda, L.T. electricity was passed through it, the wheat was sown, and the results were satisfactory. The treated grain showed plants which were stronger, taller, and with more and better ears. In all these experiments along with the treated seed, under exactly similar conditions, untreated seeds were sown. The method is slow; one cannot harvest every week. To begin with, wheat, oats and barley were taken.

The seed is now treated in tanks of varying sizes, to hold 10 or 20 sacks; each end of the tank has an iron plate serving as the electrode, the source of the electricity being the town supply or a dynamo, and a rheostat for regulating the strength of the current is necessary. The seed is treated, the solution run off, and the seed taken out and dried. The drying is very important, for if the grain is overdried it will be killed; if

underdried considerable damage is done to germination; the drying may be done by various methods. The drying of vegetables is now a fine art, and some improvements can be expected in this direction. The seed should be sown within a month or two of treating. Mr. Baines has shown in his studies on vegetable electrophysiology that every seed and vegetable has a permanent electrical charge; there is a tendency to revert to the normal if the seed is kept too long. The results in regard to wheat, oats, and barley are unqualified successes. Potatoes treated show a 50 per cent. increase in weight, electrified seed shows an increase in grain and sometimes in straw; the increased yield of grain is well over six bushels per acre.

The process so far has been spread by recommendation from farmer to farmer. The Board of Agriculture has investigated the matter, and reaped, thrashed, and weighed samples of the crops, and has found an average increase of 10.5 bushels to the acre to the credit of the electrified seed. The Board, however, is not prepared to say to what extent this is due to the chemical soaking or the electrical change. In February of this year the Board republished experiments made 40 years ago by two Germans. The experiments consisted in soaking and drying seed. Now the German rarely originates an idea, and these experiments were not original, but the electro-chemical treatment is original. In my own experience, and in another department (for it is well sometimes to get out of one's usual rut) the comparative effects of merely soaking or treating by electricity in addition may be easily shown. Take the case of the soldier left after a wound with a stiff knee joint. One may apply salt and water for any length of time to the joint, but no result will ensure; as soon, however, as a current of electricity is passed through the joint with pads of salt and water applied the joint will become movable.

The inventor of this process having succeeded, after years of experimentation, in bringing the process to maturity for the principal farm crops, and in securing a large increase of yield from all kinds of seed corn, is now turning his attention to other agricultural and to horticultural seeds. Much progress has been made in adapting the process to seeds of garden crops as well as to those of farm crops other than cereals; but with respect to them the process is not yet quite sufficiently matured to warrant his recommending its general adoption.

The results for 1918 were as follows in five cases:—

	Gain per acre in grain.	Gain per acre in straw.
1. Mr. W. W. Lovelace, Puddlehinton, Dorchester.	Wheat, 7 bushels.	2 tons, 8 cwt.
2. Mr. C. Foot, Bincombe, Dorchester.	Wheat, 6¼ bushels.	Loss, 1 cwt.
3. Mr. H. H. Cake, Bincombe, Dorchester.	Barley, 16 bushels.	Gain, 9 cwt.
4. Mr. H. Legg, Blashenwell, Corfe Castle.	18 bushels.	Gain, 10 cwt.
5. Mr. W. W. Lovelace, Puddlehinton.	Oats, 6 bushels.	Gain, 4 cwt.

During the season now closing more than 500 farmers have grown cereals treated by the Wolfryn electro-chemical process. Measured tests have been made by some of the farmers themselves, and some by an expert appointed by the chief executive officer of the Dorset Executive Committee. The Agricultural Committee of Bucks. has made an examination of some of the treated crops in its county, but a few only of the results have yet been definitely reported. One of wheat in Somerset, made by the farmer himself, shows a gain in favour of the treated seed of about 25 per cent., or three sacks per acre, in the grain; another of wheat in Dorset made by an expert shows a gain of about 33 per cent. in the grain, or more than four sacks per acre. Many farmers report that they are satisfied with their results, but are not willing to incur the trouble and expense of making measured tests. One important farmer in Midlothian writes: "I am not surprised to hear of the good results from treated seed in England. All our grain was treated with the exception of about 2.5 acres of wheat and 1 acre of oats. I am highly satisfied with the results. One only needs to stand and look to see the difference between the treated and untreated—longer and stronger straw and a much brighter colour, thicker on the ground and bigger heads." Others have reported equally favourably. Mr. D. Finlayson states: "On August 13th I visited Mr. Pledge's farm for the purpose of inspecting and reporting upon the wheat there. On the surface the evidence goes strongly to the treated side of the field. On standing at the dividing line between the two portions one is struck, most certainly, by the difference. In my opinion, the sturdier growth of the treated side will have a crop containing less, if any, shrivelled grains than the untreated."

"The spectre of famine has hung over these islands during the war, and Mr. Hoover is reported to have said that in the event of the American harvest failing to the extent of 20 per cent. there would be little doubt Europe would suffer to a terrible extent. It behoves therefore all engaged in agriculture to use all available measures to increase production. By sowing improved wheat, the application of suitable and efficient manures, and the electro-chemical treatment of seed grain, production can be increased to an enormous extent. Greater endorsement of research and a hearty co-operation between all branches interested, in which Government assistance must be liberally given, will be essential factors in a successful issue."

Discussion.

Mr. A. E. Baines (London) said that it was impossible to doubt the fact that the process of seed electrification as carried out by Mr. Fry had the effect of increasing yield, but he did not think the scientific basis underlying the process in question was yet understood. He was at first inclined to attribute the favourable results obtained to the solution of calcium, in which the seeds were immersed, for the reason that calcium was a true plant food, and that, to his mind, it was quite impossible for the seeds to retain an added charge after removal from the bath. It was necessary to understand clearly the electrical structure of seeds and the bearing of that structure upon germination. The basic principle of them all was the same. In normal conditions of weather the air was the positive and the earth the negative terminal of Nature's electrical system. Between these two there was an ordinary electrical circuit, down from the air and up through the roots, stem, and venation of the plant from the earth. In its completed, its matured state, every seed, electrically considered, was a Leyden jar. In the horse-chestnut the seed-coat was, when planted in the damp soil, the equivalent of the outer-coating of tin-foil. Within that were two insulating layers—one fibroid and the other the membranous coating of the seed—these represented the glass of the jar, while the inner coating of tin-foil was supplied by the markedly acid seed-substance itself. Before the seed was planted in the soil the seed-coat was dry and non-conducting; therefore, while it was in that condition it was electrically inert. The seed-coat must be rendered conductive before the electrical stimulus essential to germination could be imparted to the seed. The first step in Mr. Fry's process was to accomplish this, and in this fact there was also a reason for steeping certain seeds, such as those of the canna and bamboo, in water prior to planting them. His difficulty was: the seeds were charged in the bath to a potential much higher than that of the surrounding air. Would they not part with their charge upon removal from the bath, or at any rate at once lose it upon contact with damp soil? The answer would be in the affirmative, and they would conclude that the results obtained were due to chemical action alone. But they would, he was convinced, be arriving at a false conclusion. When a number of seeds were sown they did not all make equal progress or indeed germinate at the same time. That, he suggested, was due to inequality of condition at the time of sowing: they were not all fully matured seeds. Now, in the acorn the embryo radicle, plumule, and cotyledons were ensconced in a species of bag at the apex of the seed, and growth commenced at, as it were, the open mouth of the bag. In some acorns the formation could be plainly seen, in others it was not discernible. With regard to electrical stimulus, he had found from repeated experiments that to obtain some effect continued stimulus was unnecessary. If seeds were planted in electrified soil and electrification continued only for a few hours an impetus to germination was given, and the seeds made more rapid and better progress than seeds not so treated. The effect, in all probability, was to mature them, and this could readily be seen if seeds were subjected, in a pot, to a continuous current of, say, 1 volt for two or three hours, then left for a month or two and compared with other non-electrified seeds as controls. The embryo radicle and plumule would then be seen in them all. The sign of current, however, was of importance. Positive at the bottom of the soil and negative at the top gave an upward driving force, and stimulated upward growth, to the detriment of root production, while reversed polarity stimulated root-production without materially affecting growth in other ways. In the case of potatoes so treated he had had one with twelve shoots, and not a vestige of root, and the other with normal foliage and the pot filled with roots. In grasses the foliage of the first was hair-like and 18 in. high, with a few thin roots, and the second 10 in. high, robust, and so thick with roots that no soil could be seen upon removal from the pot. His considered opinion, therefore, was that the dried electrified seeds could not retain their charge for many minutes after being sown, but that the electrical stimulus imparted to them by the process was of great value.

Dr. Bletchley (Rothamsted) said her experience was that the same results were not obtained in the laboratory under carefully controlled conditions as were said to be obtained in the field. She had been working with electrified seeds at Rothamsted for two years. It had been claimed that the treatment hastened germination sometimes by three or four days. Personally, she had found that there was either no difference in germination between treated and untreated seeds, or if there was, the treated seeds were a day or two later than the untreated seeds. The plants from the treated seeds were never any better than those from untreated seeds, and in one or two cases they were distinctly behind. Generally, by the time cultivation came there was very little difference to be seen between the two. Even if there was any advantage it was by no means certain that the treatment had the same effect in all soils. In some it might be positively harmful. They had not carried out field experiments at Rothamsted.

Mr. Ross Thompson suggested that the increase in bushels per acre, whether of oats, wheat, or barley, would depend upon the nature of the soil: whether it was heavy, clay, or light loam.

Mr. G. H. Garrad said that the trials carried out at Wye last year were a failure. This year it appeared that the results from the treated seed would be better, but as harvest time approached the two sets became level, and he did not

think there would be any difference in the final result. In dealing with this matter, the author had spoken of successes, but he thought they had a right to ask also for some record of the failures.

Mr. H. H. Dunn, F.L.S., speaking as one of the first seed merchants in the country to become interested in the process, gave an account of his experiences with field crops. In company with two hard-headed practical farmers, he had inspected the growing crops on an extensive acreage, and both he and his friends had arrived at the conclusion that "there was something in it." Since then he had carefully inspected many crops in the South of England which were grown from electrified seed alongside of crops grown from untreated seed under identical conditions, and in his estimation ninety per cent. of the crops grown from electrified seed were better than those from untreated—and threshing results had confirmed his opinion. He was not financially interested in the process, and hoped the whole process would be thoroughly investigated. He deprecated the absence of the local farmer from the meeting, and suggested that the British Association, in charging for tickets, had kept away some thirty farmers, and he thought that at least ten of these gentlemen could have given the meeting the results of their own experiments with electrified seed.

Dr. Anderson, replying to the discussion, agreed that drying the seed in a kiln should increase the yield, but in his tests the seeds were also given an electrical charge after being heated in a kiln. The difference was very marked in the first experiments. Although it had been stated that in the Rothampsted laboratory, where pots were used, there was no difference in the results, it had been found that last year and the year before in several instances, although the results appeared to be identical, when the grain was threshed and weighed, the results were very different, as much as 25 or 30 per cent. in some cases. As regards the question of the effect of the soil, he was afraid there had not been sufficient experiment yet to determine that. The use of the process was too much in its infancy to say what the effect of various soils would be. With regard to potatoes, he had said that the results this year were not good. As to the Lincolnshire trials, he could not say what the results were.

Chemical Section.

Presidential Address by

Prof. P. Phillips Bedson, D.Sc. (*Abstract.*)

Fifty years ago Mendeléef communicated to the Russian Chemical Society a memoir which has exercised a profound influence on chemical philosophy, and continues to serve as a guide in the interpretation of research and speculations on the nature of the elements; we may look on this year as the jubilee of the Periodic Law.

The memoir shows the principle of periodicity—viz., the recurrence of similar properties at regular intervals with increase in the magnitude of atomic weights, the possibility of utilising the atomic weights as a basis of the classification of the elements, the necessity for the revision of the values thus assigned to the atomic weights of certain elements, and finally that the scheme demanded for its completeness the existence of many new elements.

Undoubtedly the clearest demonstration of the association between the atomic weights and the physical properties of the elements is that exhibited by the curve of atomic weights and atomic volumes, which shows the members of the natural families of elements occupying corresponding positions on the curve.

A valuable guide in fixing the atomic weights of the elements has been the specific heat, which varies in the case of solid elementary bodies inversely with their atomic weights; or, as is more usually expressed, the solid elements have the same atomic heats. The specific heat is influenced by temperature, and at about 50 deg. absolute the atomic heats of the elements are a periodic function of the atomic weights. Further, the graphic representation of this relation gives a curve very similar in its course to that of the atomic volume curve. So that the specific heat is another of the physical properties to fit into the periodic scheme.

Undoubtedly the most fascinating feature of the periodic system is that it allows the discovery of many new elements to be foreseen.

Upon the discovery of argon, helium, and their companions, in a very short period was recognised the existence of a group of gaseous elements forming a natural family, whose molecules are monatomic, the members of which are distinguishable by their spectra and atomic weights, but are all in agreement in their unreadiness to take part in any chemical change. This inertness or nonvalence provided a simple means of reconciliation with the periodic scheme of the elements, as all that was required was simply to add to the eight groups of the table of elements a zero group containing helium, neon, argon, krypton, and xenon, with niton, the emanation from radium, as a recent addition.

The elements of the argon group form a valuable extension to the periodic system, and the knowledge acquired in the investigation of these substances has proved serviceable in the solution of problems in the realms of science and of industry. The knowledge of the properties and behaviour of helium was destined soon to play a part in the solution of the riddle of the radio-active elements, whilst it is specially noteworthy that argon, the "idle one," should have been pressed into industrial service.

This fact suggests the thought that idleness has its uses, and at the present time how satisfactory would it be were we able to find useful application for a quantity which appears to be plentifully and widely distributed in this country.

We are told "that the advances made in the production of helium warrant the opinion that, had the war continued after November 11th, 1918, supplies of helium at the rate of 2,000,000 cubic feet per month would have been produced within the Empire and the United States, and helium-filled aircraft would have been in service."

With the discovery of radium and its remarkable properties we have been brought in contact with an element undreamt of in our philosophy. The interpretation of the results of the investigation of this element has called for drastic changes in our conception of an element.

Radio-activity has supplied a method of analysis—radio-active analysis—surpassing in delicacy any of the previously known methods for the examination of material substance; the application of these methods has not only added to the list of elements, but also new classes of elements. First, elements indistinguishable and inseparable by chemical means, yet differing slightly but definitely in their atomic weights. The existence of these "isotopes," as Soddy styles them (a name giving prominence to the fact that such elements occupy the same place in the table of the elements), demonstrates that absolute uniformity in the mass of every ultimate atom of the same chemical element is not an essential, but that "our atomic weights merely represent a mean value around which the actual atomic weights of the atoms vary within certain narrow limits."

The investigations in the field of radio-activity have further brought to light that identity in atomic weight may be associated with difference in chemical properties, revealing the existence of a further class of elements for which Dr. Stewat suggests the name "isobares." Further, Dr. Stewart considers that isobaric elements are to be found not alone amongst the radio-active, but some of the normal elements exhibit properties which may be explained on the assumption that they are isobarics. Thus the compounds formed from iron are regarded as indicating the existence of three irons, all having the same atomic weight. One of these, termed ferricum, is tervalent; one, ferrosum, is divalent; whilst the third, ferron, is inert and takes no part in chemical changes. The three are under certain conditions mutually interconvertible. This last condition does not apply in the case of the radio-active isobares.

The elements are to be regarded as divisible into three classes: (1) Isotopic elements, each set of which has different atomic weights but identical chemical properties; (2) Isobaric elements which have identical atomic weights but different chemical properties; (3) normal elements which differ from each other both in atomic weights and chemical properties.

The discovery of X-rays may be acclaimed as having added a new sense to aid us in our investigation of material objects, and to their innumerable services may be reckoned the results which have followed from the investigations of the X-ray spectra of the elements by the late Lieut. Moseley, whose death in Gallipoli in 1915 is one of the many tragedies of the war specially deplored in the scientific world. From the analysis of the X-ray spectra, Moseley has shown that for each element a value can be deduced, which is styled the atomic number and which represents the space in the atomic table the element should occury. The researches of Rutherford and Andrade on lead and radium B have proved that "isotopes" have the same atomic number. Whatever may be the ultimate explanation of the meaning of the atomic numbers, their experimental determination has already proved valuable in the solution of some of the anomalies of the Periodic Table.

Among the numerous revelations and surprises of the past five years has been the realisation on the part of the public and the Government of the importance of the chemical industries to the national well-being. The apathy and indifference of pre-war times were replaced by an apparently lively interest in things chemical, and there was what in the religious world would be styled a revival.

The Government, discarding its fiscal policy, was induced to subsidise the enterprise for the manufacture of dyes and other coal-tar products. The negotiations preceding the formation of the "British Dyes, Ltd." were remarkable as revealing that in the eyes of some, at any rate, special knowledge is a "dangerous thing," and, in fact, was deemed sufficient to exclude its possessors from a seat on the directorate. This is all the more remarkable as the history of similar enterprises in Germany shows the *personnel* of the directorates to be made up of university-trained men, and, in not a few instances, of professors. So that in Germany academic distinction and theoretic learning are not considered as excluding the possession of commercial acumen and those other qualities needed in a successful man of business.

In the foreword of the publication "Reports on Costs and Efficiencies for H.M. Factories," issued by the Ministry of Munitions, we are told "when it was decided to commence the erection of new and national factories . . . there was—practically throughout the entire country—a regrettable lack of available accurate technical data, and even greater lack of trained technical men—more particularly chemical engineers."

To anyone acquainted with the conditions existing in this

country in pre-war days, the lack of "trained technical men" is no matter of surprise. In fact, one cannot fail to be astonished at the phenomenal development of chemical manufacture which has taken place under the directing influence of Lord Moulton, in response to the call from the Army and Navy. That men were found capable of taking a part in these varied undertakings cannot, at any rate be credited to the encouragement which the teaching of chemistry or the students of the science had received from those directing industries, which employ or should employ the services of chemists. It is no uncommon experience to find the chemist employed simply in the analytical testing of raw materials and manufactured products, and even in the working of processes under their control the potentiality of the chemist is not utilised to the full. According to the publication mentioned above, "until comparatively recently, either intentionally or through negligence, it was customary at many chemical plants to keep the chemists in complete ignorance not only of the cost at their plant but also even of the efficiencies. It is amazing that manufacturers can expect improvements in chemical processes when their chemists are kept in ignorance of such vital facts. It has happened very often that as soon as detailed figures were seen by chemists at a plant, important alterations and improvements have at once been suggested, the need for which would otherwise never have been noticed."

The conditions of service indicated in the passage quoted, together with the low scale of remuneration which obtained hitherto in chemical industries, help to explain the scarcity of the kind of scientific labour referred to.

But are we not told and invited to believe that all this is changed? The many activities operating for the promotion of scientific research, and such evidence as that supplied by the magnificent endowment of the chemical department of the University of Cambridge, are evidences of what we may reasonably hope to be a happy augury for the future of chemistry and chemists in this country.

The Three-Electrode Thermionic Vacuum Valve.

By Dr. W. H. Eccles. (*Abstract.*)

Section A.—Mathematical and Physical Science.

During the war dark hints reached the civilian that a revolution was taking place in wireless telegraphy, the principal agent in which was reported to be an instrument called a "valve," a "lamp," or a "tube." The complete name of the instrument is the three-electrode thermionic vacuum tube. It must be emphasised that it is the three-electrode valve, and not the valve with two electrodes that has been responsible for the overthrowing of the old methods and apparatus. That it has been a veritable revolution can be seen by comparing the common practice in wireless telegraphy of 1914 with that of 1919. In 1914 practically all the most powerful transmitting stations in the world generated waves by sparks, and signals were received at nearly all stations by means of crystal or magnetic detectors. The spark method of generating waves involved the use of very large antennæ for spanning great distances. To-day we find most of the high power stations for long-distance transmission are "continuous wave" stations, that is, they produce uniform uninterrupted waves instead of a series of short gushes made by sparks; while at the receiving end new modes of detecting these continuous waves appropriate to, and taking advantage of, their uniformity in character have been introduced. This is where the three-electrode tube in all its various adaptations enters the arena. Taken together the improvements at both ends of the span have made possible the use of smaller antennæ at transmitting stations and have almost removed the necessity for any antenna at all at receiving stations. For example, under reasonable weather conditions it is quite easy to listen to the messages coming from stations on the other side of the Atlantic by using a receiving circuit of which the receptive element is a small coil of wire 3 or 4 ft. square. This does not mean that the use of an antenna for reception is abolished; on the contrary, when these highly magnifying methods are put into operation with large antennæ it is possible under reasonably good weather conditions to receive at the antipodes the signals from a modern high-power station. In accomplishing this the magnifications in use amount to several hundred-thousand-fold. When the three-electrode tube is made in large sizes it can be used for producing alternating current of high frequency and of considerable power, and then it can be employed for transmitting electric waves; the triode can be used for modulating the alternating current just spoken of and so for impressing upon the waves the human voice. In this way speech has been transmitted freely across the Atlantic.

The valve consists of three conductors in a vacuum, one of the conductors being usually a filament, which can be kept hot by the passage through it of an auxiliary electric current. The three conductors are called electrodes, and the hot one is given the special name of "cathode." When the cathode is hot enough electricity evaporates out of it into the vacuum. This disembodied electricity, apparently quite free from gross matter, consists of innumerable very small portions called electrons, which spread into the vacuum and may be caught and conducted away as electric current by either of the other electrodes. Since the electron is highly electrified and possesses very little inertia, its movements are inconceivably rapid. In consequence the three-electrode tube may be operated at the very highest frequencies of alternation used in wireless telegraphy without showing any signs of tardiness. In passing it is worth remarking that the process of thermionic evaporation briefly mentioned above is really a method of obtaining electricity from matter without the use of moving parts—that is, without machinery. Possibly it may lead to the long-sought-for method of obtaining electricity and power direct from fuel without steam boilers, engines, or dynamos. In other words, the electric engines of the future may be based upon thermionic processes deriving their energy direct from coal. Before that time comes, substances may have been discovered from which the emission of electricity takes place more easily than it does from the refractory metals we most frequently employ in the filaments of three-electrode tubes. It is known already, for instance, that some of the earthy oxides are greatly superior to platinum or tungsten in this property of emission of electricity. A new condition of matter, or a new substance, may be involved here and awaiting investigation.

In the three-electrode tube of wireless telegraphy only one of the cold conductors is intended to carry appreciable current from the vacuum to the outside circuits, and it is given the special name of "anode." It is made of large surface so as to accomplish its task. The third electrode has as its principal function the control of the flow of the electron current from cathode to anode. Control is exercised by charging this electrode electrically as and when the user desires; for when it is made negative it repels many of the just evaporated electrons back into the filament, and when it is made positive it encourages them to leave the filament and travel to the anode. The anode and the control electrode can be of almost any shape, and may have various positions relative to the cathode, but, of course, the most convenient and effective dimensions and positions have already been worked out. One arrangement of the three electrodes that is at the same time simple and eminently practical is that known as the "French" receiving pattern. It has been made in hundreds of thousands for use in the war. The anode is a short circular nickel cylinder with open ends, roughly speaking, about the size of the ferrule of an umbrella. The cathode is a filament of tungsten, and is stretched along the axis of the cylinder. Between the two comes the control electrode which is a helix of wire ¼ in. in diameter and ¾ in. long, and surrounds the filament. This helix is usually called the grid. The tube is used by connecting a high voltage battery of, say, 100 volts between anode and cathode, while the filament is kept hot by its auxiliary current, and then the flow of electricity across the vacuum amounts to 1/200th part of an ampere. Then if the grid is made positive with respect to the filament (by aid of a voltaic battery or otherwise) the current across the vacuum increases in response, and when it is made negative the current decreases. Within certain limits the responses of the anode current to the suggestions of the grid are faithful copies, and take place in a much briefer time than a millionth part of a second. Moreover, the responses of the main current to the application of a very small voltage to the grid are perhaps 10 times as great (or in some tubes 20 times) as if the voltage were applied directly in the main circuit. The device is thus a multiplier of voltage as well as a repeater.

The three-elctrode tube hereafter called a "triode" has found applications in every branch of wireless telegraphy and telephony. There is no doubt it will prove equally useful in other branches of applied electricity, and also as a tool in the hands of the experimental physicist. For instance, one fundamental property of the triode is that an electrical influence in one circuit may, by acting upon the control electrode, be made to exert effects in another circuit without suffering appreciable reaction; which implies that practically no energy is absorbed by the control electrode, not even so much as would be used up in setting a galvanometer needle into motion. This property alone should make the instrument welcome as a tool in the physical laboratory.

Then again the combination of triodes in cascade so as to obtain very large magnification opens up new regions of research by aid of the ear, and sanguine persons even anticipate that we shall some day hear the clatter of the collision of individual atoms with one another. Besides this the triode provides a very convenient means of generating oscillations of exceedingly high frequency, which opens illimitable fields of measurement upon the properties of matter and of electric waves. I shall make it my aim in opening this discussion to introduce these possibilities to physicists rather than to discuss wireless telegraphy.

Amplifiers.—The apparatus known as the amplifier is a straightforward combination of triodes and transformers devoted solely to the task of magnifying very small electric currents. Transformers are used in linking the triodes to each other, and to the outside apparatus, because the unassisted tubes would not be so effective. The small current to be magnified is passed through the primary winding of the first transformer, so as to induce E.M.F. in the secondary winding, and the secondary is connected to the grid of the first tube. The induced E.M.F. is, therefore, in a position to control the large current in the other circuit of the first tube, but the magnitude of the induced E.M.F. is greater the greater the number of turns in the secondary winding. Evidently it is profitable to make the induced E.M.F. as big as possible. The once-magnified effect appearing in the main circuit of the first tube is passed through another transformer, so that a relatively high E.M.F. is induced in its secondary winding, and this is connected to the grid of the second tube. In an

exactly similar way the output of the second tube is transformed and applied to the third tube. In this way polystage amplifiers can be built to work with either high or low frequency currents. And for some purposes they can be tuned so as to obtain in addition the magnification produced by resonance.

Amplifiers on this and on analogous schemes have been made in thousands during the war for use in earth telegraphy, in submarine listening, in telegraphy by certain invisible rays or by electromagnetic induction, as well as for use in wireless telegraph stations. Besides this, it is possible to build amplifiers for work at 10 or 20 vibrations per second, using a vibration galvanometer as the indicating instrument. The sensitiveness of some apparatus developed in my laboratory during the war is such that it is possible to detect with certainty alternating current corresponding to *one ten-thousand-millionth part of a volt* at the input side. Magnifications of the order twenty thousand times are here involved. This tempts one to revive old dreams of trans-oceanic telegraphy by means of alternating currents delivered into the sea at the ends of long cables. Calculation shows that by aid of a cable 50 miles long on each side of the Atlantic Ocean, capable of delivering about 40 amperes alternating current of a frequency of 20 cycles, telegraphic communication ought to be possible by aid of the three-electrode tube.

Generation of Oscillations.—Perhaps the uniform generation of electrical oscillations in a circuit by aid of a triode is one of the most striking and fascinating of its applications. Rather special apparatus is required to tell that oscillation is taking place and the interest excited is, therefore, scientific; very little apparatus is needed for a bare demonstration of the phenomenon, viz., an oscillatory circuit, comprising a coil of wire and an electrical condenser, and the triode with its two batteries. The three electrodes of the triode have to be connected to three points on the coil; the cathode must be connected to the middle and not to either of the end points of the coil. The circuit is now oscillating, which can be proved by coupling a thermal instrument to the coil.

Why it oscillates is best explained by a mechanical illustration. A tuning fork arranged to oscillate continuously is so arranged that two electromagnets act upon its prongs, one being in the control circuit of the triode and the other in the main circuit. The movement of the one prong induces E.M.F. in its electromagnet, and this being connected to the grid is in a position to control the main current, which, in its turn, on traversing its own magnet winding in the correct sense, sustains the motion of the fork. The electrical oscillator is operated in a precisely analogous manner, but electrical oscillators can be designed to oscillate far faster than any piece of steel, even at speeds of 100 million per second.

Sub-generative Magnification.—It is usually found on analysing an oscillator that the maintenance of the oscillations largely depends upon the interaction of two portions of the coil on each other. If it be arranged that these two parts can be separated so as to interact less strongly the oscillation becomes weaker. There is a critical setting where oscillations are just not maintained, and the system is poised in suspense, so to speak. When it is in this condition a very feeble stimulus, if properly timed, can provoke the system into vibration; the resulting display is energetic to an extent out of all proportion to the initial stimulus. Evidently enormous magnification is possible in this manner with a single triode. Its most important application is in wireless telegraphy, and many ships are equipped with this type of receiver. By its aid, spark signals can be read at distances that are amazing compared with the old records. Its principle can be shown by coming down from wireless to audible frequencies and putting a telephone in the main circuit of the triode to make the oscillations manifest.

Reception by Circuits already in Oscillation.—If the experiment just indicated is tried to find what order of magnification is obtained by the sub-generative method, it will be discovered that on passing gradually from this adjustment to the oscillating condition, other phenomena arise. If the incoming oscillations which one is trying to magnify are unceasing and uniform, and of nearly the same audible frequency as that natural to the oscillator, a throbbing takes place in the formerly steady musical note of the telephone. The throb appears only when the input current is really being introduced into the oscillating system, and is more marked the greater the original strength of the current that is to be magnified; but the input necessary to produce a perceptible amount of throbbing is exceedingly small. It would seem that the input current when it reaches the grid becomes magnified first by the more ordinary processes of the triode (already explained), and then combines with the local oscillations to produce what the musician calls "beats," and then the beats are themselves magnified by circuits of the triode. At any rate this affords what is probably the most sensitive method of perceiving a very feeble alternating current. But with a particular magnitude of oscillation coil and condenser there is a rather narrow range of frequencies, within which the incoming feeble alternating current must lie. The ordinary amplifier has a much wider range of frequencies, and is superior to the present method in that respect.

The phenomenon is indeed a true beat phenomenon; for if the sustained oscillator has a frequency of, say, 400, and the incoming current a frequency of 402, or 398, there are two beats per second in the sound from the telephone exactly in accordance with the known rules of acoustics. If the experiment were carried out on the wireless range of frequency, say, with the perfectly inaudible frequency of 400,000 per second for the oscillator and 402,000 per second for the incoming current—a note of the audible frequency 2,000 per second is heard in the formerly silent telephone immediately the incoming current is switched on. Thus, out of two high-frequency currents each incapable of exciting the telephone and ear there arises a current of a frequency equal to their difference, which may easily fall within the limits of audibility. This method is universally used in the reception of the continuous waves of modern wireless telegraphy. For not only does the method possess this merit of yielding an audible note, but it is found to give enormous magnification as well.

As carried out in wireless, the operator at a receiving station sets his apparatus near the wave length he desires to receive and then causes his triode to sustain his circuits in oscillation. The waves from the distant station, acting upon his antenna, produce minute currents in the antenna which are transformed so as to apply an E.M.F. to the grid of the triode. The result is an audible note in the operator's telephone each time the key of the transmitting station is depressed, provided, of course, the frequency of the receiver is near enough to that of the incoming waves. He can adjust the local frequency at will, and make it very near to the waves or very different from them; these adjustments alter the pitch of the beat note, and he chooses the more agreeable and efficient setting for the reception in hand. This process of receiving continuous wave signals on an oscillating circuit is called autoheterodyne or, sometimes, endodyne reception. Here a fact comes strikingly to light which is of the utmost importance to the physical laboratory, namely that the beat note changes very rapidly with change of the capacity of the condenser in the oscillating circuit.

Dr. Eccles illustrated his lecture by demonstration and experiments.

Discussion.

Prof. C. L. Fortescue asked whether it was possible to so accelerate the electrons that they were bound to radiate a very large proportion of their energy. Was not the use of any form of violent agitation of the electrons fundamentally inefficient? That was a question, perhaps, which ought to be fully investigated before very much time was spent upon other research work. Numerous points also arose in connection with the grid electrode. They were immediately up against the problem of the occluded gas. That was one of the most difficult problems met with in the construction of satisfactory and reliable tubes. Although this problem was usually associated with the positive electrode, he did not think it was by any means confined to the positive electrode only. The term occlusion was rather wide, but he thought the two things of most interest were the surface absorption and the way in which the gases could be kept in the valves in the form of solid solutions, either entrapped in the crystals themselves or in amorphous layers between the crystals. Exactly how they were retained there was a matter about which a great deal more was required to be known. This occluded gas must be got rid of so that there was no further liberation of gas during the time the valve was in use. With the smaller valves, which were not subjected to very high temperatures, one thorough cooking was sufficient, but for the larger ones it was rather a long process. The valve might be subjected to a heavier electrode bombardment and temperature than it would ever be subjected to in ordinary use, and it was piously hoped that no more gas would find its way out in ordinary circumstances. The evidence indicated that no further gas did come out, if it was properly treated. The question also arose: what was the nature of the gas which came out from the electrode afterwards, or during the time exhaustion was taking place. Numerous attempts had been made to examine the gas. It could be done in two or possibly more ways. For instance, the spectrum could be observed; to a tube which had become somewhat soft such a high voltage could be applied that the blue glow appeared, and that blue glow could be examined. Many of the well-known gases could be dealt with in that way, but some of the spectra were different from what was ordinarily expected. Then there was the process of a tube working at a high voltage tending to harden, and at a low voltage to soften. There was a kind of vapour pressure depending on the tension under which the tube was used, and full investigation of that was required. An interesting suggestion had been put forward by one of his colleagues at Woolwich to explain some of these actions. His notion was that the gases going into, and coming out of, the electrodes, either in use or during the exhausting process, were related to the well-known positive condition of metals at relatively low temperature, and he visualised the process as follows: that it was only ionised gas, particularly ionised hydrogen, which took part in entering and leaving the surfaces. The positive ion was moved with considerable force, as a projectile, and had very considerable penetrating properties. It pierced the outer layer and found itself surrounded by a number of the free electrons within the conducting surface. Being encumbered by these electrons, it cannot get out of the hole it came in, and that theory was to some extent borne out by the observed fact that the gas which came out of the cathodes was undoubtedly ionised. It had been observed frequently that a

small quantity of gas coming out of the electrodes would set up an arc far more easily than considerably greater quantities introduced from the outside. That was a suggested theory which he thought was interesting. With regard to the outer envelope, glass was almost universally used at the moment for the simple reason that it was a non-conductor, and it was possible to make vacuum-tight joints, but it was fragile. It tended to crack with change of temperature, and there was also a tendency for chemical action at the seams, when working at high temperatures. On the other hand, if the temperature was low, the glass softened and collapsed. There were other alternatives and there might be an entirely different construction for the envelopes for high powers where the power was being expended inside the tube alone. Dr. Forrest, in an American specification, had described one possible arrangement, in which a metallic container was used which served as the positive electrode, the filament being led in through glass tubes. That was suggestive of many possible constructions, but they were immediately up against the problem of securing a really vacuum-tight joint. The vacuum used in these thermionic tubes was of the order of 10^{-4} mm. of mercury, and a very slight leakage was fatal. A better method than that at present in use was wanted. Many different designs had been adopted, but although the valve was at present a commercial thing, he saw no reason why the existing form of construction should be the final form. At present it required very careful handling, but in order to dispel the idea that it was extremely delicate he exhibited a valve which had been through a fire in the wireless room of one of our new ships at Portsmouth, and was little the worse for it, notwithstanding every receiving instrument and a considerable number of transmitting apparatus had to be replaced. Altogether there were seven valves in that wireless room, and four of them were found to be quite serviceable after exposure to the high temperature of the fire.

Mr. B. S. Gossling said the thermionic valve could now be regarded as a fully fledged electrical instrument, for it was now performing important functions in trunk telephony and in wireless telegraphy and telephony. At the same time, it could not be said that there was a very complete understanding of the working of these devices and their possibilities, and until all the phenomena going on inside the valve were clearly understood and recognised their knowledge must be regarded as deficient. At the time of the armistice these valves were being made at the rate of 500,000 per annum, and careful tests were made upon a considerable number of them. Records of these tests for tens of thousands of valves were available, and it was known within a high degree of certainty what was the range of variation. Nevertheless, the physical phenomena involved and how the thing actually worked in practice were still far from clearly understood. The improvement in the working of the valves was shown by the fact that the variation in accuracy of working between different valves was at one time as much as 200 or 300 per cent.; but that had now been reduced to *plus* or *minus* 10 per cent. under practical conditions.

Major R. Whiddington, speaking of the substitution of coal gas for air, said he had been trying experiments based on his experience of the possibilities of the valve. The periodicity of the oscillations of the anode circuit depended not only on the capacity of the condenser, but also to a slight degree on the resistance of the circuit, and to a very great extent on the inductance of the coil. That could be illustrated by passing the ions from a flame through the coil, *i.e.*, by blowing the ionised gas from the gas burner through the induction coil; a distinct change in the note heard on the telephone was noticeable. He illustrated the extreme sensitiveness of the apparatus. A similar experiment was to take a branch off the anode circuit—a copper wire—and heat it in a flame. A very slight change of resistance in the wire was sufficient to alter the note again.

Sir Oliver Lodge, F.R.S., said that the valve in the hands of physicists was an instrument of research which could not but be of great service. The point which specially interested him was how far they were beginning to use atomic energy. Here was an atomic atom, with electrons revolving round it, and he presumed it was one of those electrons which was flying off at a certain temperature. Where did the energy come from? He supposed the magnifying energy came not from the metal itself, but from the battery. That was the only assumption, although he did not know that it was necessarily true, because instead of a hot filament they might have a radio-active element and might utilise some spontaneous radio-activity. Had spontaneous radio-activity been used in a valve? There might be reasons against it, but anything that was throwing off electrons would do equally well and be much more efficient. It would be almost like using a permanent magnet instead of an electromagnet. In that case, they should be using atomic energy. There were other ways of getting electrons flying off from the metal. A clean metal illuminated by ultra-violet light threw off electrons; the light energy would be very small, and any of these processes might be utilised instead of a hot wire. He had always felt that the utilisation of heat was an inefficient method, a random method, but applying synchronised ethereal vibrations to the atoms would be doing it in a more intelligible manner.

Dr. W. Makower, with regard to the question of getting a valve to work by radio-active processes, said that it could be done, but it must obviously be a very tiny valve indeed. All they had to do was to take a plate of pollonium, instead of a filament, giving off alpha rays, and by putting a thin plate over that, delta rays were given off. The only difficulty was to get a supply of electrons which would be sufficient to do anything in the nature of work. Nevertheless, he imagined that there would be no trouble in making a valve which would give an extremely small total emission; instead of being measured in milliamperes, it would be measured in fractions of micro-amperes.

Mr. S. G. Brown said he himself was now trying to cover the filament with lime, and put a plate on the outside of the lime. The device worked exceedingly well, but the difficulty was that the lime burned out between the plates and the grid. That showed that the process took place inside the lime as well as outside, in the vacuum space, and he thought the reason why the lime allowed electrons to escape so easily was that lime was practically an insulator, in a hot state.

Dr. W. H. Eccles, in reply, agreed heartily with everything that had been said. The only thing he wished to comment upon arose out of Sir Oliver Lodge's remark with regard to the inefficiency of the thermal process of making electrons. Many of them had imagined ways of getting rid of the loss occurring in that way, when thinking of big tubes. He did not think it was worth while worrying about with small tubes. He could imagine, for instance, a large sphere as large as a room plated inside with a brilliant reflecting metal to form the anode, and if they had a little sphere, heated to white heat, in the centre, there would be no need to supply any more heat, as it would all be reflected back. What would have to be considered was the evaporation of electrons from the central hot body.

The National Alliance of Employers and Employed.

By the Rt. Hon. F. Huth Jackson. (*Abstract.*)

Section F.—Economic Science and Statistics.

In the autumn of 1916 a group of three employers and four trade unionists met to discuss the probable effect which war conditions would have on our industrial system. These seven men, realising the gravity of the problems which already were confronting the country, and visualising the still greater problems which the future had in store, took what was then the somewhat adventurous step of initiating a movement whose whole foundation was unity of effort on the part of employers and trade unions on a basis of frankness, comradeship, and good-will.

To that small and unpretentious gathering is to be traced, not only the National Alliance of Employers and Employed, which was the immediate result, but the whole of the great movement towards co-operative effort which now promises to remould our industrial life and which recently led to the calling by the Government of the National Industrial Conference, and the setting up of the National Joint Industrial Council.

From the commencement we have realised that in industrial development there could be no middle course. The old enemies, Capital and Labour, had either to plunge into more bitter and more widespread strife or to discover a common ground on which they could get together and for themselves work out the lines of harmonious progress. In the face of innumerable difficulties, and in spite of misunderstandings and misrepresentations, the National Alliance has discovered that common ground, and to-day, in thirty of the most important industrial districts in the country, Joint Area Committees (on which, as on the central body, employers and trade unionists are represented in equal numbers) are working in harmony and understanding, not only for the peaceful reorganisation of industry as such, but for the development of higher social conditions and the raising of the standards of life.

This is just where the work of the National Alliance differs in extent from that of Whitley Committees, and even from that of the organisation to be set up in connection with the National Joint Industrial Council. We take the view that, essential though it may be, it is not sufficient for employers and employed in any one particular industry to co-operate merely for the improvement of the commercial and the working conditions in that industry. The wider problem is not solved merely by settling hours of labour, rates of pay, amounts of output, &c., and leaving such questions as the provision of healthy home surroundings, educational opportunities, recreational facilities, &c., to take care of themselves. The machinery of the National Alliance is designed not only to bring the employers and employed of a given industry together for the settlement of their own especial problems, but also to link up the employers and employed of all industries in a particular area in a joint endeavour to improve the general conditions in that area.

The work which the National Alliance has taken in hand is a great and difficult one, but on its accomplishment depends the future of our country. The evil centuries of hatred and struggle between the forces of Capital and Labour have built high and wide their barriers of antagonism and dark mistrust. They cannot be swept away in a day, but the experience of the National Alliance has shown that on each side there is an increasing number of earnest, thoughtful, far-seeing men who are realising the errors of the past, and who are willing to join in a great national fellowship for the security of the future.

ELECTRIC POWER COLLECTION.*

By CHARLES P. STEINMETZ.

In the development of sciences and industries which have advanced as rapidly as electrical engineering, we frequently strike barriers which seem to stop further progress, until some new idea carries us around the apparently unsurmountable barrier and the beyond shows us a field of development vastly greater even than what had before been considered as the final possibilities. Or more often it is an old idea, which though discarded in the earlier days of development, leads us beyond the barrier which had stopped progress. Thus, when we see development slow down and apparently the limit of progress reached in certain directions, it is advisable to go back to the earlier days and search whether, amongst the ideas then unsuccessfully tried, we may not find some which lead to success under the changed conditions.

A good illustration is given by the history of electric lighting. Metal filaments were tried but found wanting in the early days, before the carbon filament, and for a quarter of a century the latter held sway. But after the first few years of rapid advance, progress slowed down and apparently the ultimate limit had been reached at about three watts per mean spherical candle-power. Then the old idea of the metal filament, backed by the 20 years' advance of chemical engineering, carried us around the barrier and more than quadrupled the efficiency of incandescent lighting.

If ever progress was important, and especially engineering progress, beyond the barriers retarding the advance, it is now, in our present period of the world's reconstruction. But to progress beyond barriers, we first have to see and realise those barriers, and long familiarity with existing methods of doing things tends to standardise our thoughts, and leads us to consider as essential and inherent, features which are only incidental and due to the conditions under which the development has taken place, and disables us, when these conditions change, to see beyond the incidental limitations. Standardisation is useful and important, and indeed industrial progress would be impossible in the chaos which would result without standardisation, but standardisation becomes harmful when extending to our thoughts whether and how things can be accomplished. One of the first ways to realise and overcome this limitation is to review the development and ask ourselves why it has taken place in that particular direction, how far the course of development has been due to temporary conditions and whether with the change of these conditions a different direction of development may lead us beyond the possibilities of our present achievements.

The electric generator and the electric motor are identical; where there are differences in construction, they are in details, to accentuate certain characteristics for certain purposes.

Looking back over the electrical development of the last quarter of a century, we have seen the size of generators and generating stations steadily increase. The maximum size of motors also has steadily increased; but the average size of motors has increased little, if at all, due to the increasing use of individual motors, applied directly to the driven machines. The average motor is installed with a switch to start it, and a fuse to stop it in case of overload or accident, and then left to itself with practically no attention. In the generator installation, however, we find a very elaborate system of controlling and protective devices, &c., requiring continuous and highly skilled attention. Why is this, if generator and motor are the same type of apparatus? Obviously, it is not due to the use of the machine, in the one case as motor, in the other case as generator, but it is due to the size of the machine, indeed, in the installation of very large motors, we find more controlling and protective devices than a switch and a fuse. Inherently a generator installation is no more complex than a motor installation. Thus if the average size of generator installation has steadily increased, while the average size of motor has not, this is not due to the complexity required in the former, but the reverse is the case, the complexity of the generator installation is the result of its huge size.

The difference in the course of development of motor and generator thus must be found in other directions. As an instance, let us consider a typical electric motor development.

When the first cotton mill was electrified in 1894, the steam engine was taken out, and a 400-H.P. synchronous motor put into its place, driving by belts and shafts and countershafts the individual machines, that is, the power was generated electrically, but distributed mechanically. But in the new mill of the same plant, a number of 100-H.P. induction motors were installed, each driving a line of shafting to which the individual machines were belted, that is, at least a part of the power distribution was done electrically. I need not say that even this is antiquated, and that the most economical arrangement is to entirely eliminate mechincal power distribution and distribute all the power electrically, that is, to have individual motors at every machine. This is the reason why the average size of electric motor is small, corresponding to the power required by the individual machine, and large motors are used only where a large unit of mechanical power is required, as at the rolls of a steel mill, or the propeller of a battle cruiser.

But in electric generation we are still in the first stage, that typified by the huge synchronous motor distributing power mechanically through numerous belts, shafts, and countershafts. We collect the power of a watershed mechanically by elaborate hydraulic works, costing many times more than the most elaborate electric generating station, and then in a big unit convert the hydraulic, that is, mechanical power into electric power in a modern synchronous generating station. Or we burn millions of tons of coal under the steam boilers of our huge steam stations, extract 10 to 15, or possibly 20 per cent. of its energy as electric power, and then pay for the condensing water to throw away the 80 odd remaining per cent. of the heat energy of the fuel, while in numerous other furnaces we burn millions of tons of coal to produce heat, but waste the potential mechanical and electrical energy of this coal.

This is not a condition to make us proud of our industrial efficiency. But it came about naturally, as the result of historical development.

The first electrical development occurred where hydraulic power was available in concentrated form, at waterfalls such as Niagara, &c., that is, cases corresponding in motor development to the rolling mill or the ship's propeller. The synchronous machine is the proper type of generator for such installations, just as the synchronous motor is the preferable type of motor for large units of power unless special conditions prevail and demand the induction motor. The same type of hydro-electric development was extended to conditions where water power was available in less concentrated form, and had to be collected by more extensive hydraulic works, gathering together the power of a watershed, and so the modern hydro-electric generating system was developed as the most perfect known method, within its scope and limits of utilising water power—mechanical collection of the water power by hydraulic works, and conversion to electric power in a big-unit synchronous generating station.

But the high cost of the hydraulic work makes such development economically feasible only where large amounts of water power are available in fairly concentrated form, and with the increasing development of such power sites, the number of water powers capable of development by our present methods is decreasing, while most of the country's potential water powers can not be developed by our present standard methods of hydroelectric generation, as the cost of the necessary hydraulic development, to collect the water power, is greater than the value of the power which may be collected. The only hope which can be seen for a more complete utilisation of our country's hydraulic power, from the abandoned mill sites of New England to the mountain streams of the south and the west, thus lies in applying to the electric generation the same principles which have made the electric motor economically successful, that is, bringing the electric machine to the place of power. That is, just as we place individual motors at every machine where mechanical power is required, and distribute the power to them electrically, so to place individual electric generators wherever along the water course hydraulic power is available, and collect the power of all these generators electrically.

For these relatively small individual generators, required for electric power collection, induction machines would naturally be used just as induction machines are exclusively used for smaller units of motors, however superior the synchronous motor is for larger powers.

Such a small induction generator station then would consist of a standard low-voltage induction motor connected to some simple and cheap hydraulic turbine, a few hundred feet of pipe, and a low dam across the creek, to cover the intake of the pipe; a step-up transformer connecting the machine to a medium-voltage collecting line, L.T. switch and fuse to disconnect in case of accident. Hundreds of such small induction generating stations then would feed into the system over collecting lines, just as hundreds of induction motor installations receive power from it over distribution lines, and a large synchronous main station—steam turbine or hydraulic, or possibly even merely a synchronous motor station—would control the voltage and frequency of the system.

In similar manner, a simple and cheap turbine induction generator plant, interposed between the high-pressure steam boiler and the steam heating system which it supplies, would abstract the small percentage of fuel energy which is available in conversion to mechanical and electrical power, and turn it into the electrical distribution system, on which the induction generator floats, thus collecting electrical energy from numerous small steam stations and eliminating the present wasteful use of coal.

Now this development of electric power collection is coming, as it is the natural economic development of electric generation, just as the individual motor drive was in electrical power distribution. There are already a number of such hydro-

* *General Electric Review*, August, 1919. (*Abstract.*)

electric induction generator installations throughout the country, some in successful operation for years, and the field thus opened up is very large, larger possibly than all the electrical development which has taken place hitherto, and one of the features of this development is that no new type of apparatus requires to be developed, but the standard induction motor can be used as an induction generator, and has been used successfully for years in some cases.

NEW PATENTS APPLIED FOR, 1919.

(NOT YET PUBLISHED.)

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21,399. "Obtaining alternating currents of any frequency from existing three-phase systems of any other frequency." A. M. TAYLOR. September 1st.

21,410. "Manufacture of tubular articles by electric welding." R. F. WOODBURN. September 1st.

21,415. "Electric signalling systems." WESTERN ELECTRIC CO. (Western Electric Co.) September 1st.

21,446. "Electric fuses, heating elements, &c." A. F. BERRY. September 1st.

21,448. "Detecting distant ships whereon dynamo-electric machinery, &c., is running." Q. C. A. CRAUFURD and L. O. DOUGHTY-WYLIE. September 1st.

21,449. "Signalling through water." Q. C. A. CRAUFURD and L. O. DOUGHTY-WYLIE. September 1st.

21,450. "Apparatus for detecting presence of passing ships." Q. C. A. CRAUFURD and L. O. DOUGHTY-WYLIE. September 1st.

21,460. "Electrical terminal." O. G. NEATE. September 1st.

21,497. "Method of varying electric current through electro-magnets or solenoids in automatic musical instruments." H. R. KIDNER. September 2nd.

21,514. "Electric signalling systems." WESTERN ELECTRIC CO. (Western Electric Co.) September 2nd.

21,515. "Automatic switching mechanism for telephone, &c., systems." AUTOMATIC TELEPHONE MANUFACTURING CO. (Automatic Electric Co.) September 2nd.

21,523. "Electric signalling for railways." J. HUNTER. September 2nd.

21,524. "Thief-proof motor-car electric switch and lock combined." G. W. ELLIOTT. September 2nd.

21,548. "Automatic time switches for interrupters for electrical circuits." J. J. DJERRGAARD. September 2nd. (Denmark, July 13th, 1917.)

21,568. "Magneto-electric ignition machines." SCINTILLA. September 2nd. (Switzerland, September 2nd, 1918.)

21,582. "Electric furnaces." D. DE LUCA. September 2nd.

21,583. "Electric water heaters." AKT-GES. R. FRISTER. September 2nd. (Germany, December 9th, 1916.)

21,585. "Electrodes and electrical accumulators." O. SCHNEIDER. September 2nd. (Germany, November 3rd, 1917.)

21,586. "Miners' electric lamps." F. SCHLEGEL and O. SCHNEIDER. September 2nd. (Germany, November 9th, 1918.)

21,598. "Electric cables and joint boxes for same." A. D. CONSTABLE. September 3rd.

21,603. "Magnetic frictional variable speed gearing." G. TOWNSEND. September 3rd.

21,618. "Electric light fittings." S. T. JORDAN. September 3rd.

21,624. "Electric transmission systems and cables therefor." WESTERN ELECTRIC CO. (Western Electric Co.) September 3rd.

21,637. "Fool-proof self-relay circuit breaker." F. DAVIES. September 3rd.

21,656. "Electric welding apparatus." BRITISH THOMSON-HOUSTON CO. (General Electric Co.) September 3rd.

21,685. "Electric control mechanisms." G. WEISMANN. September 3rd. (France, August 10th, 1917.)

21,692. "Apparatus for electrically locating oil-bearing strata." W. R. MCDONALD. September 3rd.

21,712. "Appliance for disinfecting telephones." A. E. CLAUSON. September 4th.

21,714. "Electric switches." E. DOBSON and FOSTER ENGINEERING CO. September 4th.

21,775. "Incandescent lamps." BRITISH THOMSON-HOUSTON CO. (General Electric Co.) September 4th.

21,779. "Electrical oscillatory circuit." W. H. LYONS and SELECTIVE SIGNAL CO. September 4th.

21,783. "Push button controls of motor starters." IGRANIC ELECTRIC CO. and A. H. MACKLEY. September 4th.

21,787. "Means for measuring electrical constants of an oscillatory circuit." C. K. CHANDLER. September 4th.

21,809. "Electric welding apparatus." A. E. FRANKLIN. September 4th.

21,814. "Thermo telephones, &c." F. H. FOUNTAIN. September 4th.

21,829. "Contacts for electric switches, fuses, &c." W. REDMAYNE. September 5th.

21,835. "Obtaining currents of two periodicities from one generating unit." H. A. L. BARRY. September 5th.

21,841. "Electro-magnetic wave signalling systems." J. HOLLINGWORTH. September 5th.

21,842. "Wood separators for electric accumulators." FULLERS UNITED ELECTRIC WORKS and G. FULLER. September 5th.

21,855. "Electric reactive windings." J. R. BEARD and ELECTRICAL IMPROVEMENTS, LTD. September 5th.

21,860. "Sparking plugs." F. A. L. JOHNSON. September 5th.

21,868. "Conduit fittings for electric cables." R. S. MILLER. September 5th.

21,876. "Electric plugs." H. N. H. COBBOLD and PORTHOLME AIRCRAFT CO. September 5th.

21,885. "Electric water-heaters." FILBAR ELECTRIC HEATER, LTD., and C. KRATT. September 5th.

21,891. "Electric wave form indicators or oscillographs." P. TRICHARD. September 5th.

21,892. "Electric frequency multipliers." P. TRICHARD. September 5th.

21,897-8. "Automatic electric couplings." R. BELFIELD. (Westinghouse Air Brake Co.) September 5th.

21,957. "Electrical equipment of motor vehicles." R. L. ASPDEN and F. H. BOWMAN. September 6th.

21,966. "Electric pendant." J. E. BARBER, H. N. BURR and W. F. MERRY. September 6th.

21,984. "Electrical receiving apparatus for telegraphs, &c." F. A. JOHNSEN and K. RAHBEK. September 6th.

21,991. "Electrical systems for preventing collision on single-line railways." D. J. AKHOONA. September 6th.

21,992. "Electric fans." P. H. D. PUDUMJEE. September 6th.

PUBLISHED SPECIFICATIONS.

The numbers in parenthesis are those under which the specifications will be printed and abridged, and all subsequent proceedings will be taken.

1917.

5,161. ALTERNATING CURRENT MOTOR. G. Sartori. April 12th, 1917. (130,620.)

12,980. ELECTRIC STARTING AND IGNITION OF AEROPLANE ENGINES AND THE LIKE. Leyland Motors and J. G. P. Thomas. September 10th, 1917. (131,005.)

1918.

4,935. HIGH-FREQUENCY ELECTRIC INSTALLATIONS. G. A. Bauvais. December 14th, 1917. (131,018.)

5,241. ELECTRICAL TRANSFORMERS. J. L. Thompson and British Westinghouse Electric and Manufacturing Co. March 25th, 1918. (131,026.)

5,305. ELECTRIC ARC LAMPS. H. B. Grylls and W. Heape. March 27th, 1918. (131,028.)

5,423. FEEDING AND ROTATING MEANS FOR ELECTRODES OF SEARCHLIGHTS AND THE LIKE. E. A. Sperry. March 27th, 1917. (131,030.)

5,618. TUNING DIAPHRAGMS FOR GENERATING OR RECEIVING SOUND WAVES. L. V. King. April 2nd, 1918. (131,041.)

5,886. TELEPHONE INSTALLATIONS, PARTICULARLY FOR WIRELESS TELEGRAPHY. L. N. Brillouin. October 8th, 1917 (131,054.)

5,887. TELEPHONE INSTALLATIONS, PARTICULARLY FOR WIRELESS TELEGRAPHY. L. N. Brillouin. October 8th, 1918. (131,055.)

5,927. AUDION OR LAMP RELAY OR AMPLIFYING APPARATUS FOR USE IN TELEPHONY. M. Latour. April 15th, 1916. (Divided application on 5,363/17.) (131,056.)

5,937. ELECTRICAL RESISTANCES. S. R. Mullard. April 6th, 1918. (131,057.)

6,039. ELECTRIC FURNACES. J. A. Fleming. April 9th, 1918. (131,061.)

6,260. ELECTRICAL SIGNALLING APPARATUS. N. Turner. April 12th, 1918. (131,066.)

6,829. SPARKING-PLUGS FOR EXPLOSIVE MOTORS. J. F. Ledanois. April 23rd, 1918. (131,076.)

7,083. AUDION OR LAMP RELAY OR AMPLIFYING APPARATUS. M. Latour. April 30th, 1917. (Addition to 5,363/17.) (131,092.)

10,933. ELECTRIC SELECTORS, PARTICULARLY FOR AUTOMATIC TELEPHONE SYSTEMS. Western Electric Co. (Western Electric Co.) July 3rd, 1918. (131,106.)

11,709. TELEPHONE REPEATER SYSTEMS. C. Robinson and R. M. Chamney. July 17th, 1918. (131,113.)

11,710. TELEPHONE REPEATER SYSTEM. C. Robinson and R. M. Chamney. July 17th, 1918. (131,114.)

12,477. DIRECT CURRENT STARTING SWITCHES FOR ELECTRIC MOTORS. J. S. Macintosh. July 31st, 1918. (131,116.)

12,653. SECONDARY ELECTRIC BATTERIES OR ACCUMULATORS. Tudor Accumulator Co. and W. E. Spencer. August 2nd, 1918. (131,117.)

13,038. ELECTRICAL HEATING APPARATUS. M. J. Railing, J. H. Farthing and F. Winstanley. August 12th, 1918. (131,129.)

13,050. ELECTRICAL SIGNALLING APPARATUS. Sir W. G. Armstrong, Whitworth & Co., C. B. Chicken and J. H. Thain. August 12th, 1918. (131,131.)

13,104. MEANS FOR MAKING TEMPORARY CONNECTIONS WITH ELECTRIC SUPPLY CABLES. J. H. Collie. August 13th, 1918. (131,135.)

13,105. CURRENT COLLECTORS FOR ELECTRICALLY PROPELLED VEHICLES. R. H. Wilkinson and A. R. Fearnley. August 13th, 1918. (131,136.)

13,349. ELECTRIC MOTORS. M. V. O'Leary. August 16th, 1918. (131,156.)

13,549. ELECTRICAL FUSE DISTRIBUTION BOX. R. T. Norton and A. C. Robinson. August 21st, 1918. (131,162.)

13,614. METHOD AND MEANS FOR OPERATING DISTANT DEVICES BY MEANS OF ELECTRO-MAGNETIC WAVES. A. G. Bloxam. (Russische Akt.-Ges. L. M. Ericsson & Co.) August 21st, 1918. (131,166.)

13,984. MANUFACTURE OF NATURAL GRAPHITE ELECTRODES. E. Ridoni and Soc. Talco E. Grafiti Val Chisone. March 6th, 1918. (123,972.)

14,160. ELECTRICAL APPARATUS FOR DETECTING OR INDICATING THE PRESENCE OF HIGH-TENSION OR EXTRA HIGH-TENSION SPARKS OR DISCHARGES. N. Stell. August 31st, 1918. (131,180.)

14,680. DYNAMO-ELECTRIC MACHINERY. Lo-Thermo Patents, Ltd., B. Longbottom and E. Greenhalgh. September 10th, 1918. (131,185.)

15,045. ELECTRICAL SWITCH. A. J. Bonella and R. K. Damey. September 16th, 1918. (131,191.)

16,996. ALTERNATING-CURRENT DYNAMO-ELECTRIC MACHINES. G. H. Fletcher and British Westinghouse Electric and Manufacturing Co. October 17th, 1918. (131,204.)

21,110. ELECTRICAL SWITCHES. R. T. Norton. December 18th, 1918. (131,223.)

1919.

219. DISTRIBUTOR DEVICES FOR IGNITION APPARATUS. Remy Electric Co. April 4th, 1917. (122,187.)

730. ELECTRIC LAMP-HOLDERS. H. Bey. January 10th, 1919. (Patent of addition not granted.) (131,230.)

965. WORMGEAR ADJUSTMENTS APPLICABLE TO VARIABLE CONDENSERS FOR WIRELESS TELEGRAPHY AND TELEPHONY. W. H. Edbridge and E. E. G. Boite. January 14th, 1919. (Addition to 4,057/18.) (130,888.)

2,882. MEANS FOR SECURING ELECTRIC CONDUCTING WIRES TO THEIR INSULATORS. H. Marsicano. February 5th, 1919. (130,901.)

3,887. ELECTRIC SWITCHES. M. E. Callegaris. February 17th, 1919. (131,239.)

4,151. ELECTRICAL RESISTANCES. L. F. A. Fogarty and C. T. Lahmann. February 19th, 1919. (130,910.)

6,108. LOCKING APPARATUS FOR LOCKING ELECTRIC LIGHT GLOW LAMPS TO HOLDERS. W. J. Bodell and T. Williams. March 12th, 1919. (130,924.)

7,071. ELECTRIC FUSE PLUGS. J. Glatz. March 21st, 1919. (131,249.)

8,794. MEANS FOR RE-ADJUSTING THE TIMING OF THE SPARK OF A MAGNETO-ELECTRIC MACHINE. T. R. Hayworth. April 7th, 1919. (130,933.)

9,189. RECTIFIERS FOR ALTERNATING ELECTRIC CURRENTS. J. F. G. P. Hartmann. November 14th, 1918. (130,936.)

10,344. HIGH-VOLTAGE CURRENT-DISTRIBUTING APPARATUS FOR ELECTRIC IGNITION APPARATUS FOR INTERNAL-COMBUSTION ENGINES. (Firm of) Scintilla. September 18th, 1918. (130,942.)

11,038. THERMO-TELEPHONIC RECEIVERS. A. Williams and L. D. Williams. May 3rd, 1919. (131,258.)

16,730. SPARKING-PLUGS FOR USE WITH INTERNAL-COMBUSTION ENGINES. J. E. Barrows. August 1st, 1918. (Divided application on 12,551/18 and 317/19, Cognate applications 2,626/19 and 16,740/19.) (131,268.)

Leipzig Fair.—According to the *Daily Dispatch*, British buyers and business men, after five years' absence, were to be seen at the Leipzig fair, which opened on August 31st, although their number was very small. The same remark applies to buyers from Belgium, Italy, and America, compared with the Czecho-Slovaks, whose number exceeded 2,000. The total number of exhibitors and buyers has greatly increased. Much business is being done in toys, porcelain, the metal industries, and machinery, and all kinds of cheap goods "Made in Germany."